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IPCC SPECIAL REPORT ON GLOBAL WARMING OF 1.5°C

An IPCC special report on the impacts of global warming of 1.5ºC above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

Final Draft Summary for Policymakers

(Submitted by the Co-Chairs of Working Groups I, II and III)

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Note:

The Final Draft Summary for Policymakers is submitted to the First Joint Session of Working Groups I, II and III for approval. The approved Summary for Policymakers will be forwarded to the Forty-Eighth Session of the IPCC (Incheon, Republic of Korea, 1 - 5 October 2018) for acceptance.

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WMO UNEP

Summary for Policy Makers

Date of Draft: 30 September 2018

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Introduction

This report responds to the invitation for IPCC '... to provide a Special Report in 2018 on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways' contained in the Decision of the 21st Conference of Parties of the United Nations Framework Convention on Climate Change to adopt the Paris Agreement.[1]

The IPCC accepted the invitation in April 2016, deciding to prepare this Special Report on *the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*.

This Summary for Policy Makers (SPM) presents the key findings of the Special Report, based on the assessment of the available scientific, technical and socio-economic literature[2] relevant to global warming of 1.5°C and for the comparison between global warming of 1.5°C and 2°C. The level of confidence associated with each key finding is reported using the IPCC calibrated language.[3] The underlying scientific basis of each key finding is indicated by references provided to chapter elements.

[1] COP 21, decision 1, para. 21

[2] The assessment covers literature accepted for publication by 15 May 2018.

[3] Each finding is grounded in an evaluation of underlying evidence and agreement. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, for example, medium confidence. The following terms have been used to indicate the assessed likelihood of an outcome or a result: virtually certain 99–100% probability, very likely 90–100%, likely 66–100%, about as likely as not 33–66%, unlikely 0–33%, very unlikely 0–10%, exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%, more likely than not >50–100%, more unlikely than likely 0–<50%, extremely unlikely 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, for example, very likely. See for more details: Mastrandrea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.-K. Plattner, G.W. Yohe and F.W. Zwiers, 2010: Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties, Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, 4 pp.

A. Understanding Global Warming of 1.5°C

A1. Human activities have caused approximately 1.0°C of global warming, with a *likely* range of 0.8° to 1.2°C. Global warming is *likely* to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. (*high confidence*) {1.2, Figure SPM1}

A1.1. Observed global mean surface temperature (GMST) for the decade 2006–2015 was 0.87°C (*likely* between 0.75° and 0.99°C)[4] higher than in 1850–1900 (*very high confidence*). Anthropogenic global warming matches the level of observed warming to within ±20% (*likely* range) and is currently increasing at 0.2°C (*likely* between 0.1°C and 0.3°C) per decade due to ongoing emissions (*high confidence*). {1.2.1, Table 1.1, 1.2.4}

A1.2. Warming greater than the global average is being experienced in many regions and seasons, including two to three times higher in many Arctic regions. Warming is generally higher over land than over the ocean. (*high confidence*) {1.2.1, 1.2.2, Figure 1.1, Figure 1.3, 3.3.1, 3.3.2}

A1.3. Changes in temperature extremes and heavy precipitation have been detected in observations for the 1991–2010 period compared with 1960–1979, a time span over which global warming of approximately 0.5°C occurred, suggesting that further detectable changes in extremes may be associated with every additional 0.5°C of warming (*medium confidence*). {3.3.1, 3.3.2, 3.3.3}

A2. Past emissions alone are *unlikely* to cause global warming of 1.5°C (*medium confidence*) but will cause further long-term changes in the climate system, such as sea level rise, with associated impacts (*high confidence*). {1.2, 3.3, Figure SPM 1}

A2.1. If all anthropogenic emissions (including greenhouse gases, aerosols and their precursors) were reduced to zero immediately, it is *likely* that further global warming would be less than 0.5°C over the next two to three decades (*high confidence*) and less than 0.5°C on a century time scale (*medium confidence*). {1.2.4, Figure 1.5}

A2.2. Reaching and sustaining net-zero CO_2 emissions and declining non-CO_2 radiative forcing would halt global warming at a level determined by net cumulative CO_2 emissions up to the time of net-zero (*high confidence*) and the average level of non-CO_2 radiative forcing in the decades immediately prior to that time (*medium confidence*) (Figure SPM 1). Net negative CO_2 emissions may still be required to sustain stable temperatures thereafter (*medium confidence*). {Cross-Chapter Box 2 in Chapter 1, 1.2.3, 1.2.4, 2.2.1, 2.2.2}

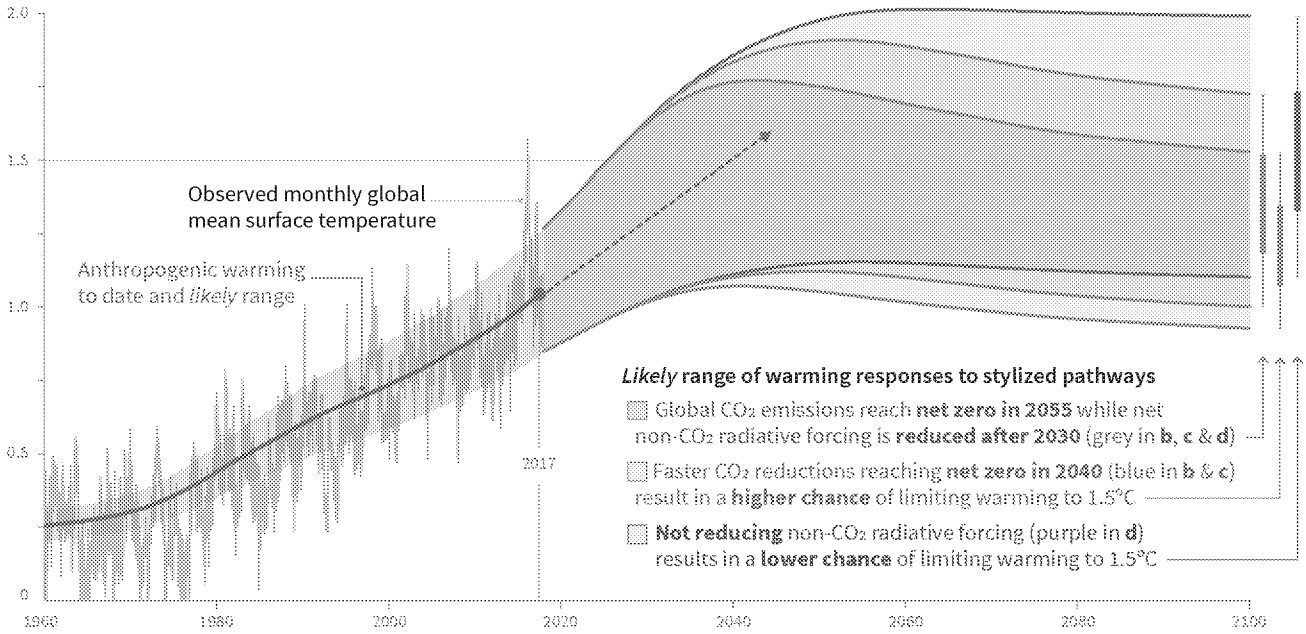
[4] This range spans the four available peer-reviewed estimates of the observed GMST change and also accounts for additional uncertainty due to possible short-term natural variability. {1.2.1, Table 1.1}

Cumulative emissions of CO_2 and future non-CO_2 radiative forcing determine the chance of limiting warming to 1.5°C

This figure uses stylized emissions and forcing pathways to show key factors affecting the prospects of temperatures remaining below 1.5°C.

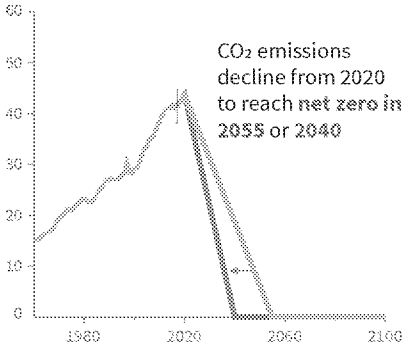
a) Observed global temperature and responses to stylized emission pathways

Global warming relative to 1850-1900 (°C)



b) Stylized global CO_2 emission pathways

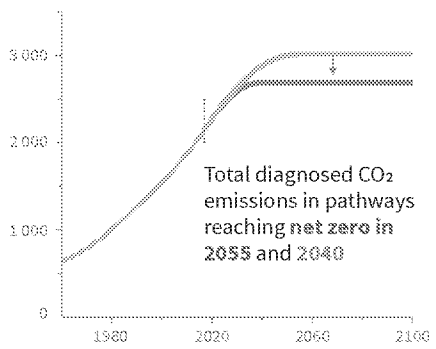
Billion tonnes CO_2 per year (Gt/y)



Faster immediate CO_2 emission reductions reduce total cumulative CO_2 emissions at the time of peak warming.

c) Total cumulative CO_2 emissions

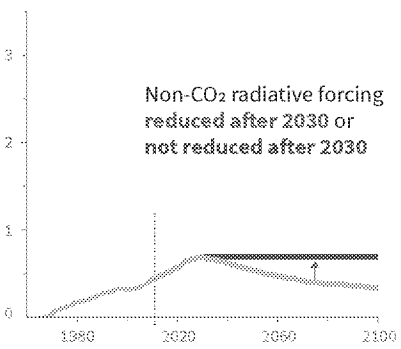
Billion tonnes CO_2 (Gt)



Maximum warming is determined by cumulative CO_2 emissions at the time of peak warming and…

d) Non-CO_2 radiative forcing pathways

Watts per square metre (W/m^2)



…maximum warming is also affected by radiative forcing due to methane, nitrous oxide, aerosols and other emissions.

Figure SPM.1: Panel a: Observed monthly global mean surface temperature (GMST, grey line to the left of 2017, from the HadCRUT4, GISTEMP, Cowtan & Way, and NOAA datasets, with varying line thickness indicating the dataset range) and estimated anthropogenic global warming to date (orange line obtained by fitting expected responses to anthropogenic and natural radiative forcing to observed GMST, displaying the anthropogenic component, with orange shading indicating assessed ±20% likely range). Grey plume on right of panel a shows likely range of warming responses to a stylized pathway in which CO2 emissions (grey line in panels b and c) decline in a straight line from 2020 to reach net zero in 2055 while non-CO2 radiative forcing (grey line in panel d) increases to 2030 and then declines, representative of the 1.5°C no or limited overshoot pathways assessed in Chapter 2. Temperature responses are computed with a simple climate carbon cycle model consistent with the assessed likely range in anthropogenic global warming in 2017. Blue plume in panel a shows the response to faster CO2 emissions reductions (blue line in panel b), reaching net-zero in 2040, reducing cumulative CO2 emissions (panel c). Purple plume shows response to CO2 emissions declining to zero in 2055 but non-CO2 forcing remaining constant after 2030. Vertical error bars on right of panel a show likely ranges (thin lines) and central terciles (33rd – 66th percentiles, thick lines) of the estimated distribution of warming in 2100 under these three stylized pathways. Vertical dotted error bars in panels b, c and d show likely ranges of uncertainty in observed annual and cumulative global CO2 emissions in 2017 and in non-CO2 radiative forcing in 2011. Vertical axes in panels c and d are scaled to represent approximately equal effects on GMST. {1.2.1, 1.2.3, 1.2.4, 2.3, Chapter 1 Figure 1.2 & Chapter 1 Technical Annex, Cross Chapter Box 2}

A3. Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C (*high confidence*). These risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options (*high confidence*) (Figure SPM2). {1.3, 3.3, 3.4, 5.6}

A3.1. Impacts on natural and human systems from global warming have already been observed (*high confidence*). Many land and ocean ecosystems and some of the services they provide have already changed due to global warming (*high confidence)*. {1.4, 3.4, 3.5, SPM Figure 2}

A3.2. Future climate-related risks depend on the rate, peak and duration of warming. They are larger if global warming exceeds 1.5°C before returning to that level by 2100 than if global warming gradually stabilizes at 1.5°C, especially if the peak temperature is high (e.g., about 2°C) (*high confidence*). Some risks may be long-lasting or irreversible, such as the loss of ecosystems (*high confidence*). {3.2, 3.4.4, 3.6.3, Cross-Chapter Box 8}

A3.3. Adaptation and mitigation are already occurring (*high confidence*). Future climate-related risks would be reduced by the upscaling and acceleration of far-reaching, multi-level and cross-sectoral climate mitigation and by both incremental and transformational adaptation *(high confidence)* {1.2, 1.3, Table 3.5, 4.2.2, Cross-Chapter Box 9 in Chapter 4, Box 4.2, Box 4.3, Box 4.6, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5, 4.4.1, 4.4.4, 4.4.5, 4.5.3}

A4. Limiting global warming to 1.5°C compared to 2°C would make it easier to achieve many aspects of sustainable development, with greater potential to eradicate poverty and reduce inequalities, especially when mitigation actions maximize synergies (high confidence). {1.1, 1.4, 2.5, 5.2, Table 5.1}

A4.1. Climate change impacts and responses are closely linked to sustainable development which balances social well-being, economic prosperity and environmental protection. The United Nations Sustainable Development Goals (SDGs), adopted in 2015, provide an established framework for assessing the links between global warming of 1.5°C or 2°C and development goals that include poverty eradication, reducing inequalities, and climate action (*high confidence*) {Cross-Chapter Box 4 in Chapter 1, 1.4, 5.1}

A4.2. The consideration of ethics and equity can help minimize adverse effects and maximize benefits associated with pathways limiting global warming to 1.5°C, and is central to this report. Additional climate risks at 2°C compared to 1.5°C warming, as well as potential negative consequences of mitigation action, would fall disproportionally on poor and disadvantaged populations, indicating larger challenges associated with poverty eradication and reducing inequalities compared to current conditions *(high confidence)*. {1.1.1, 1.1.2, 1.4.3, 2.5.3, 3.4.10, 5.1, 5.2, 5.3. 5.4, Cross-Chapter Box 4 in Chapter 1, Cross-Chapter Boxes 6 and 8 in Chapter 3, and Cross-Chapter Box 12 in Chapter 5}

A5. Mitigation and adaption consistent with global warming of 1.5°C are underpinned by enabling conditions, assessed in this report across the geophysical, environmental-ecological, technological, economic, socio-cultural and institutional dimensions of feasibility. {1.4, Cross-Chapter Box 3 in Chapter 1, 4.4, 4.5, 5.6}

A5.1. Modelling studies identify that pathways limiting global warming to 1.5°C are enabled when considering the combination of effective international cooperation, integrated and stringent policy frameworks, access to finance, and sustainable consumption (*high confidence*) {2.1, 2.3, 2.5}.

A5.2. The availability of finance and technology, integration of institutions, inclusive processes, attention to uneven power and inequality, and reconsideration of values are critical conditions to achieve sustainable development, eradicate poverty and reduce inequalities while limiting global warming to 1.5°C *(high confidence)* {5.6}

A5.3. Strengthened multi-level governance, institutional capacity, policy instruments, technological innovation and transfer and mobilization of finance, and changes in human behaviour and lifestyles are enabling conditions that enhance the feasibility of mitigation and adaptation options for 1.5°C-consistent systems transitions *(high confidence)* {4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5}

B. Projected Climatic Changes, Their Potential Impacts and Associated Risks

B1. Climate models project robust[5] differences in regional climate characteristics between present-day and global warming of 1.5°C,[6] and between 1.5°C and 2°C[6]. These differences include increases in: mean temperature in most land and ocean regions (*high confidence*), hot extremes in most inhabited regions (*high confidence*), heavy precipitation in several regions (*medium confidence*), and the probability of drought in some regions (*medium confidence*). {3.3}

B1.1. Temperature extremes on land are projected to increase more than global warming (*high confidence*): extreme hot days in mid-latitudes by up to about 3°C at global warming of 1.5°C and about 4°C at 2°C, and extreme cold nights in high latitudes by up to about 4.5°C at 1.5°C and about 6°C at 2°C (*high confidence*). The number of hot days is projected to increase in most land regions, with highest increases in the tropics (*high confidence*). {3.3.1, 3.3.2, Cross-Chapter Box 8 in Chapter 3}

[5] Robust is here used to mean that at least two thirds of climate models show the same sign of changes at the grid point scale, and that differences in large regions are statistically significant.
[6] Projected changes in impacts between different levels of global warming are determined with respect to changes in global surface air temperature.

B1.2. Limiting global warming to 1.5°C compared to 2°C would reduce the probability of increases in heavy precipitation events in several northern hemisphere high-latitude and high-elevation regions (*medium confidence*). Compared to 2°C global warming, less land would be affected by flood hazards (*medium confidence*) and the probability of droughts would be lower in some regions, including the Mediterranean and southern Africa (*medium confidence*). {3.3.3, 3.3.4, 3.3.5}

B2. By 2100, global mean sea level rise would be around 0.1 metre lower with global warming of 1.5°C compared to 2°C (*medium confidence*). Sea level will continue to rise well beyond 2100 (*high confidence*), and the magnitude and rate of this rise is expected to depend on future emission pathways. A slower rate of sea level rise would allow more effective adaptation (including managing and restoring natural coastal ecosystem and infrastructure reinforcement) in small islands, low-lying coastal areas and deltas exposed to increased saltwater intrusion, flooding, and damage to infrastructure (*medium confidence*). {3.3, 3.4, 3.6}

B2.1. Model-based projections of global mean sea level suggest an indicative range of 0.26 to 0.77 m by 2100 for 1.5°C global warming (relative to 1986-2005), 0.1 m (0.04-0.16 m) less than for a global warming of 2°C (*medium confidence*). A reduction of 0.1 m in global sea level rise implies that up to 10 million fewer people would be exposed to related risks, based on population in the year 2010 and assuming no adaptation (*medium confidence*). {3.4.4, 3.4.5, 4.3.2}

B2.2. Sea level rise will continue beyond 2100 even if global warming is limited to 1.5°C in the 21st century (*high confidence*). Marine ice sheet instability in Antarctica and/or irreversible loss of the Greenland ice sheet could result in multi-metre rise in sea level over hundreds to thousands of years. There is *medium confidence* that the threshold for such instabilities could lie around 1.5 to 2°C. {3.3.9, 3.4.5, 3.5.2, 3.6.3, Box 3.3, SPM Figure 3.2}

B3. On land, risks of climate-induced impacts on biodiversity and ecosystems, including species loss and extinction, are lower with 1.5°C of global warming than 2°C. Limiting global warming to 1.5°C compared to 2°C has important benefits for terrestrial, freshwater, and coastal ecosystems and for the preservation of their services to humans (*high confidence*). (SPM Figure 2) {3.4, 3.5, Box 3.4, Box 4.2, Cross-Chapter Box 8 in Chapter 3}

B3.1. Of 105,000 species studied, 18% of insects, 16% of plants and 8% of vertebrates are projected to lose over half of their climatically determined geographic range for global warming of 2°C, compared with 6% of insects, 8% of plants and 4% of vertebrates for global warming of 1.5°C (*medium confidence*). Impacts associated with other biodiversity-related risks such as forest fires, and the spread of invasive species, are also reduced at 1.5°C compared to 2°C of global warming (*high confidence*). {3.4.3.3, 3.5.2}

B3.2. Approximately 13% of the global terrestrial land area is projected to undergo a transformation of ecosystems from one type to another at 2°C of global warming. The area at risk would be approximately halved at 1.5°C (*medium confidence*). {3.4.3.1, 3.4.3.5}

B3.3. High-latitude tundra and boreal forests are particularly at risk of climate change induced degradation and loss, with woody shrubs already encroaching into the tundra (*high confidence*). Limiting global warming to 1.5°C rather than 2°C could also prevent the thawing over centuries of an estimated 2 million km^2 of the existing permafrost area (*medium confidence*) {3.3.2, 3.4.3, 3.5.5}

B4. Limiting global warming to 1.5°C compared to 2°C is expected to reduce increases in ocean temperature as well as associated increases in ocean acidity and decreases in ocean oxygen levels (*high confidence*). Consequently, limiting global warming to 1.5°C is expected to reduce risks to marine biodiversity, fisheries, and ecosystems, and their functions and services to humans, as illustrated by recent changes to Arctic sea ice and warm water coral reef ecosystems (*high confidence*). {3.3, 3.4, 3.5, Boxes 3.4, 3.5}

B4.1. There is *high confidence* that the probability of a sea-ice-free Arctic Ocean during summer is substantially higher at global warming of 2°C when compared to 1.5°C. With 2°C global warming, at least one sea ice-free Arctic summer is projected per decade. This likelihood is reduced to one per century with 1.5°C of global warming. Effects of a temperature overshoot are reversible for Arctic sea ice cover on decadal time scales (*high confidence*). {3.3.8, 3.4.4.7}

B4.2. Global warming of 1.5°C is projected to shift species ranges to higher latitudes as well as increase the amount of damage to many ecosystems. It is also expected to drive the loss of coastal resources, and reduce the productivity of fisheries and aquaculture (especially at low latitudes). The risks of climate-induced impacts are projected to be less at 1.5°C than those at global warming of 2°C (*high confidence*). Coral reefs, for example, are projected to decline by a further 70–90% at 1.5°C with larger losses (> 99%) at 2°C (*very high confidence*). The risk of irreversible loss of many marine and coastal ecosystems increases with global warming, especially at 2°C or more (*high confidence*). {3.4.4, Box 3.4}

B4.3. The level of ocean acidification associated with global warming of 1.5°C is expected to amplify the adverse effects of warming, impacting the survival, calcification, growth, development, and abundance of a broad range of species (i.e. from algae to fish) (*high confidence*). {3.3.10, 3.4.4}

B4.4. Climate change in the ocean is increasing risks to fisheries and aquaculture via impacts on the physiology, survivorship, habitat, reproduction, disease incidence, and risk of invasive species (*medium confidence)* but are projected to be less at 1.5°C of global warming than at 2°C. Global fishery models, for example, project a decrease in global annual catch for marine fisheries of more than 3 million tonnes for 2°C of global warming versus a loss of 1.5 million tonnes for 1.5°C of global warming (*medium confidence*). {3.4.4, Box 3.4}

B5. Climate-related risks to health, livelihoods, food and water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C. (SPM Figure 2) {3.4, 3.5, 5.2, Box 3.2, Box 3.3, Box 3.5, Box 3.6, Cross-Chapter Box 6 in Chapter 3, Cross-Chapter Box 9 in Chapter 4, Cross-Chapter Box 12 in Chapter 5, 5.2}

B5.1. Populations at disproportionately higher risk of adverse consequences of global warming of 1.5°C and beyond include disadvantaged populations, indigenous peoples, and populations dependent on agriculture or coastal livelihoods. Regions at disproportionately higher risk include Arctic ecosystems, dryland regions, and small-island developing states (*high confidence)*. Poverty and disadvantage are expected to increase in some populations as global warming increases; limiting global warming to 1.5°C, compared with 2°C, could reduce the number of people exposed to climate-related risks and susceptible to poverty by up to several hundred million (*medium confidence*). {3.4.10, 3.4.11, Box 3.5, Cross-Chapter Box 6 in Chapter 3, Cross-Chapter Box 9 in Chapter 4, Cross-Chapter Box 12 in Chapter 5, 5.2.1, 5.2.2, 5.2.3, 5.6.3, Cross-chapter Box 9}

B5.2. Any increase in global warming is expected to affect human health, with primarily negative consequences (*high confidence*). Lower risks are projected at 1.5°C than at 2°C for heat-related morbidity and mortality (*very high confidence*) and for ozone-related mortality if emissions needed for ozone formation remain high (*high confidence)*. Urban heat island effects generally amplify the impacts of heatwaves in cities (*high confidence*). Risks from some vector-borne diseases, such as malaria and dengue fever, are projected to increase with the level of future warming, including potential shifts in their geographic range (*high confidence*). {3.4.7, 3.4.8, 3.5.5.8}

B5.3. Limiting warming to 1.5°C, compared with 2°C, is projected to result in smaller net reductions in yields of maize, rice, wheat, and potentially other cereal crops, particularly in sub-Saharan Africa, Southeast Asia, and Central and South America; and in the CO_2 dependent, nutritional quality of rice and wheat (*high confidence*). Reductions in projected food availability are larger at 2°C than at 1.5°C of global warming in the Sahel, southern Africa, the Mediterranean, central Europe, and the Amazon (*medium confidence*). Livestock are projected to be adversely affected with rising temperatures, depending on the extent of changes in feed quality, spread of diseases, and water resource availability (*high confidence*) {3.4.6, 3.5.4, 3.5.5, Box 3.1, Cross-Chapter Box 6 in Chapter 3, Cross-Chapter Box 9 in Chapter 4}

B5.4. Depending on future socioeconomic conditions, limiting global warming to 1.5°C, compared to 2°C, may reduce the proportion of the world population exposed to a climate-change induced increase in water scarcity by up to 50%, although there is considerable variability between regions (*medium confidence*). Many small island developing states would experience substantially less freshwater stress as a result of projected changes in aridity when global warming is limited to 1.5°C, as compared to 2°C (*medium confidence*). {3.3.5, 3.4.2, 3.4.8, 3.5.5, Box 3.2, Box 3.5, Cross-Chapter Box 9 in Chapter 4}

B5.5. Risks to global economic growth posed by climate change-related impacts are projected to be lower at 1.5°C than at 2°C of global warming (*medium confidence*). Countries in the tropics and Southern Hemisphere subtropics are most at risk because present-day temperatures in these regions are above the threshold estimated to be optimal for economic production (*medium confidence*). {3.5.2, 3.5.3}

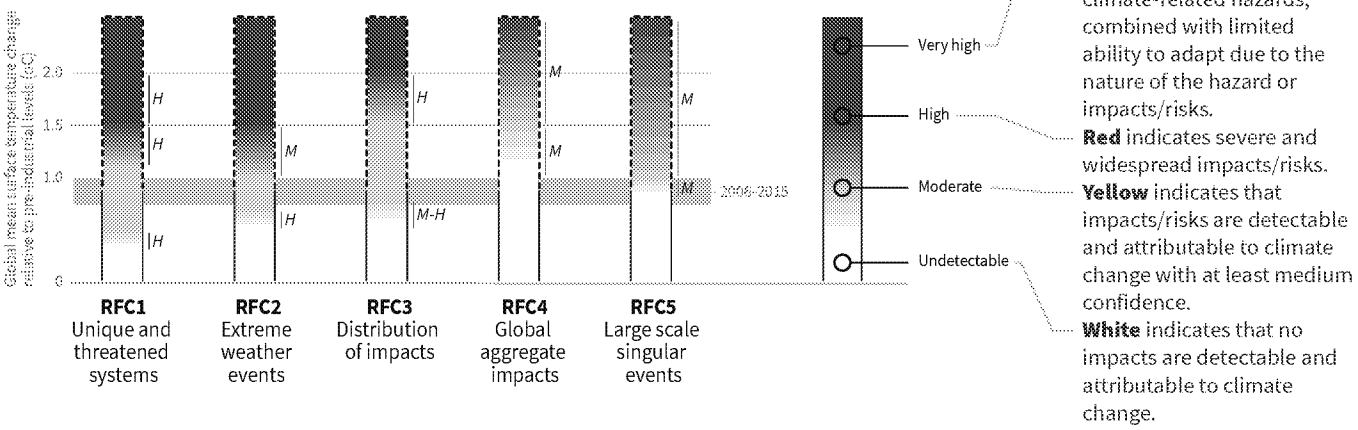
B5.6. Exposure to multiple and compound climate-related risks increases between 1.5°C and 2°C of global warming, with greater proportions of people exposed and susceptible to poverty in Africa and Asia (*high confidence*). Risks across energy, food, and water sectors could overlap spatially and temporally, creating new (and exacerbating current) hazards, exposures, and vulnerabilities that could affect increasing numbers of people and regions with additional global warming (*medium confidence*) {Box 3.5, 3.3.1, 3.4.5.3, 3.4.5.6, 3.4.11, 3.5.4.9}

B5.7. There are multiple lines of evidence that since the AR5 the assessed levels of risk increased for four of the five Reasons for Concern (RFCs) for global warming to 2°C (*high confidence*). The risk transitions by degrees of global warming are now: from high to very high between 1.5°C and 2°C for RFC1 (Unique and threatened systems) (*high confidence*); from moderate to high risk between 1.0°C and 1.5°C for RFC2 (Extreme weather events) (*high confidence*); from moderate to high risk between 1.5°C and 2°C for RFC3 (Distribution of impacts) (*high confidence*); from moderate to high risk between 1.5°C and 2.5°C for RFC4 (Global aggregate impacts) (*medium confidence*); and from moderate to high risk between 1°C and 2.5°C for RFC5 (Large-scale singular events) (*high confidence*). (SPM Figure 2) {3.4.13; 3.5, 3.5.2}

How the level of global warming affects risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

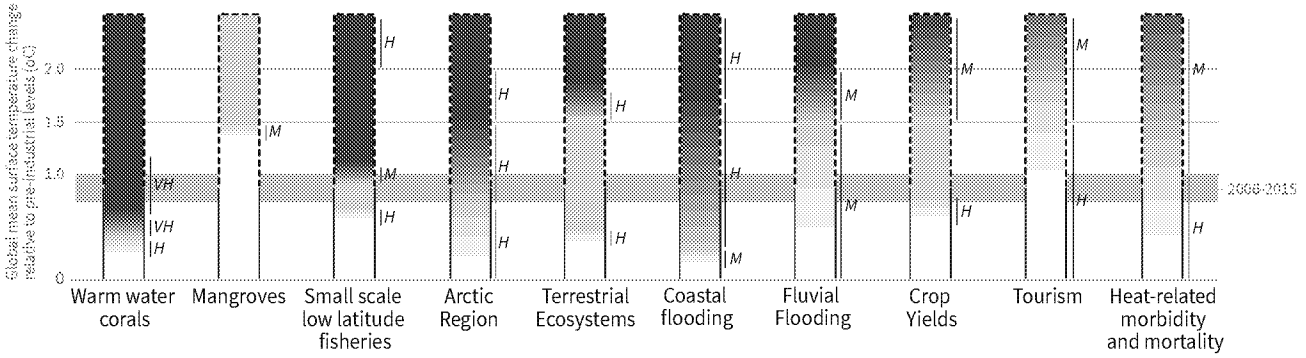
Five Reasons For Concern (RFCs) illustrate the implications of different levels of global warming for people, economies and ecosystems across sectors and regions.

Risks associated with the Reasons for Concern (RFCs)



Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.
Red indicates severe and widespread impacts/risks.
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.
White indicates that no impacts are detectable and attributable to climate change.

Risks for selected natural, managed and human systems



Confidence level for transition: *L*=Low, *M*=Medium, *H*=High and *VH*=Very high

Figure SPM.2: Five integrative reasons for concern (RFCs) provide a framework for summarizing key risks across sectors and regions, and were introduced in the IPCC Third Assessment Report. RFCs illustrate the implications of climate change and adaptation limits for people, economies, and ecosystems. Risks for each RFC are based on assessment of the new literature that has appeared. As in the AR5, this literature has been used to make expert judgments to assess the levels of global warming at which levels of risk are undetectable, moderate, high or very high. The selection of risks to natural, managed and human systems in the lower panel is illustrative and is not intended to be fully comprehensive. {3.4, 3.5, 3.5.2.1, 3.5.2.2, 3.5.2.3, 3.5.2.4, 3.5.2.5, 5.4.1 5.5.3, 5.6.1, Box 3.4}

B6. Most adaptation needs will be lower for global warming of 1.5°C compared to 2°C (*high confidence*). There are a wide range of adaptation options that can reduce the risks of climate change (*high confidence*). Limits to adaptation exist with global warming of 1.5°C. The number and availability of adaptation options vary by sector and decline for higher levels of global warming. (*medium confidence*) {Table 3.5, 4.3, 4.5, Cross-Chapter Box 12 in Chapter 5}

B6.1. A wide range of adaptation options are available to reduce the risks to natural and managed ecosystems (e.g., ecosystem restoration, avoided deforestation, biodiversity protection, agricultural irrigation efficiency, sustainable aquaculture), the risks of sea level rise (e.g., coastal infrastructure), and the risks to health, livelihoods, food, water, and economic growth especially in rural landscapes (e.g., social safety nets, disaster risk reduction, insurance, water management and reuse) and urban areas (e.g., green infrastructure, planning) (*medium confidence*). Effective options include community-based adaptation, drawing on local knowledge and indigenous knowledge, and ecosystems-based adaptation (*high confidence*). [(Table SPM.1)] {4.3.1, 4.3.2, 4.3.3, 4.3.5, 4.5.3, 4.5.4, Box 4.2, Box 4.3, Box 4.6, Cross-Chapter Box 9 in Chapter 4}.

B6.2. Adaptation is expected to be more challenging for ecosystems, food and health systems at 2°C of global warming than for 1.5°C (*medium confidence*). Some vulnerable regions, including small islands and Least Developed Countries, are projected to experience high multiple interrelated climate risks even at global warming of 1.5°C (*high confidence*). {3.3.1, 3.4.5, Box 3.5, Table 3.5, Cross-Chapter Box 9 in Chapter 4, 5.6, Cross-Chapter Box 12 in Chapter 5, Box 5.3}

B6.3. Limits to adaptation and associated losses exist at 1.5 of global warming, become more pronounced at higher levels of warming and vary by sector, with site-specific implications for vulnerable regions, ecosystems, and human health (*medium confidence*) {Cross-Chapter Box 12 in Chapter 5, Box 3.5}

C. Emission Pathways and System Transitions Consistent with 1.5°C Global Warming

C1. In pathways with no or limited overshoot of 1.5°C, global CO_2 emissions decline by at least 35% from 2010 levels by 2030, reaching net zero around 2050. For comparison, limiting global warming below 2°C[7] implies CO_2 emissions decline at least 20% by 2030 in most pathways and reach net zero around 2075. Pathways that limit global warming to 1.5°C and those that limit warming to 2°C involve similarly ambitious reductions in non-CO_2 emissions. (*high confidence*) {2.1, 2.3, Figure SPM3a}

C1.1. CO_2 emissions reductions that limit global warming to 1.5°C with no or limited overshoot can involve different portfolios of mitigation measures, striking different balances

[7] References to pathways limiting global warming to 2°C are based on a 66% probability of staying below 2°C.

between lowering energy and resource intensity, rate of decarbonization, and the reliance on carbon dioxide removal. Different portfolios face different implementation challenges, and potential synergies and trade-offs with sustainable development. (*high confidence*). {2.3.2, 2.3.4, 2.4, 2.5.3, Figure SPM3b}

C1.2. Pathways that limit global warming to 1.5°C with no or limited overshoot involve deep reductions in emissions of methane and black carbon as well as in most cooling aerosols (35% or more by 2050 relative to 2010). CO_2 mitigation measures can also reduce non-CO_2 emissions, particularly in the energy and transport sectors. Other measures can reduce agricultural nitrous oxide and methane, some sources of black carbon, or hydrofluorocarbons. High bioenergy demand increases emissions of nitrous oxide in some pathways. Improved air quality resulting from reductions in many non-CO2 emissions can provide large, direct, and immediate population health benefits. (*high confidence*). {Figure SPM3a, 2.2.1, 2.3.3, 2.4.4, 2.5.3, 4.3.6, 5.4.2}

C1.3. Revising estimates from AR5, the remaining carbon budget from the beginning of 2018 for a 50% probability of limiting global warming to 1.5°C defined in terms of the increase in global surface air temperature relative to pre-industrial is 580 $GtCO_2$, and 420 $GtCO_2$ for a 66% probability, subject to large uncertainties. If global warming is defined in terms of GMST, which warms slower than global surface air temperature, these remaining carbon budgets would be 770 and 570 $GtCO_2$ respectively[8] (*medium confidence*). {2.2.2, 2.6.1, Table 2.2, Chapter 2 Supplementary Material}

C1.4. From 1876 until the end of 2017 approximately 2200 ± 320 $GtCO_2$ were emitted by human activities. If current anthropogenic CO_2 emissions of 42 ± 3 $GtCO_2$ per year start an immediate and steady decline, staying within the 420-770 $GtCO_2$ remaining carbon budgets quoted above would imply reaching net zero CO_2 emissions in about 20 to 40 years from 2018. (*medium confidence*). {2.2.2, Table 2.2, Figure SPM1, Supplementary Material Chapter 2}

C1.5. The relative importance for remaining carbon budgets of both uncertainties and choices regarding non-CO_2 mitigation increases as global warming thresholds are approached. Uncertainties comprise the possible variation in climate response (±400 $GtCO_2$), the level of historic warming (±250 $GtCO_2$), and the role of future permafrost thawing and potential methane release from wetlands (reducing budgets by up to 100 $GtCO_2$ over the course of this century and more thereafter). Choices regarding non-CO_2 mitigation could alter the remaining carbon budget by 250 $GtCO_2$ in either direction. (*medium confidence*). {2.2.2, 2.6.1, Table 2.2, Supplementary Material Chapter 2}

C1.6. Solar radiation modification (SRM) measures are not included in any of the available assessed pathways. Although some SRM measures may be theoretically effective in reducing an overshoot, they face large uncertainties and knowledge gaps as well as substantial risks, institutional and social constraints to deployment related to governance, ethics, and impacts on sustainable development. They also do not mitigate ocean acidification. (*medium confidence*). {4.3.8, Cross-Chapter Box 10 in Chapter 4}

[8] Irrespective of the definition of global warming used, improved understanding has led to an increase in the estimated remaining carbon budget of about 300 GtCO2 compared to AR5. Roughly two thirds of this increase is due to using an improved estimate of historical warming within the carbon budget assessment, and about one third arises from using non-CO_2 emission pathways consistent with mitigation efforts aiming to limit warming to well below 2°C.

Global emissions pathway characteristics

General characteristics of the evolution of anthropogenic net emissions of CO_2, and total emissions of methane, black carbon, and nitrous oxide in pathways that limit global warming to 1.5°C with no or limited overshoot. Net emissions are defined as anthropogenic emissions reduced by anthropogenic removals. Reductions in net emissions can be achieved through different portfolios of mitigation measures illustrated in Figure SPM3B.

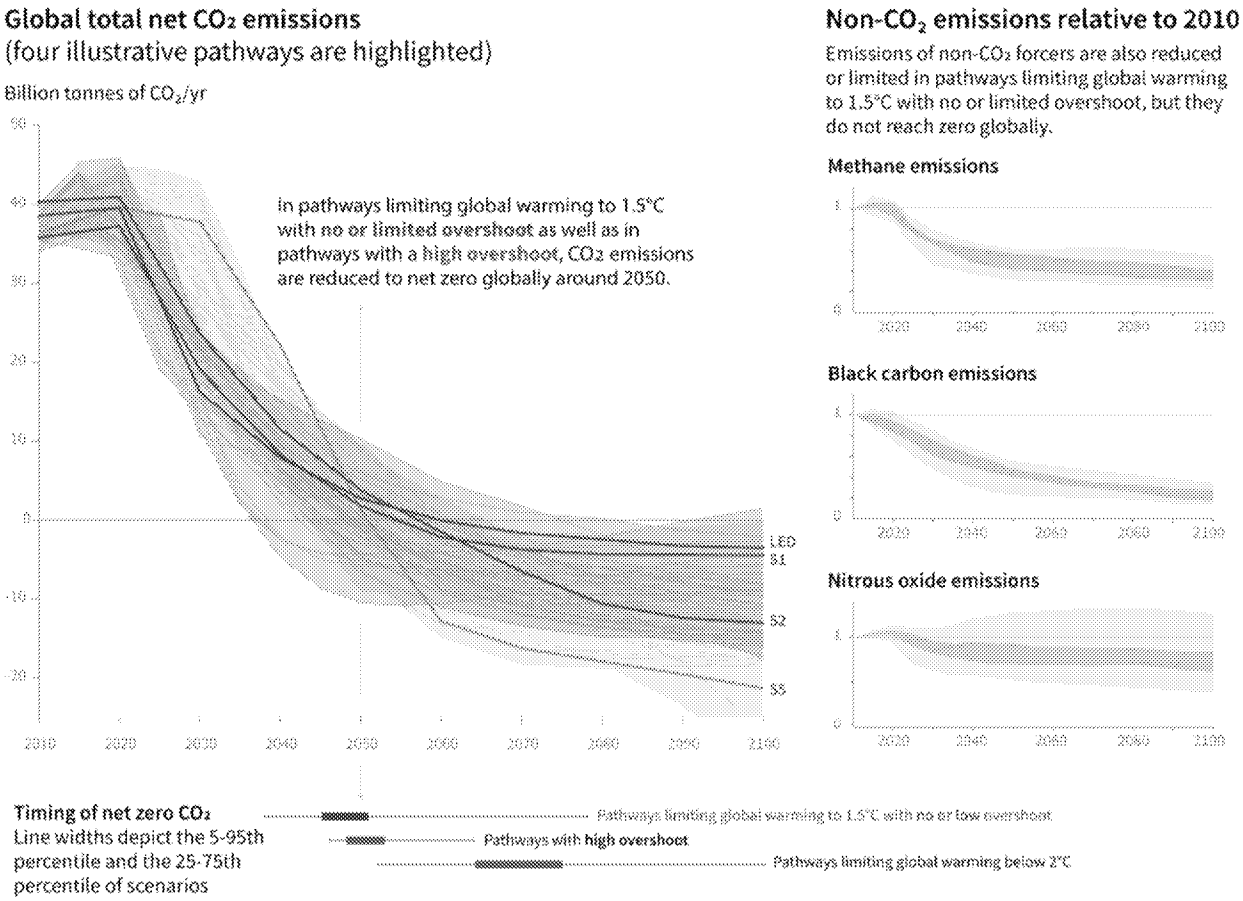
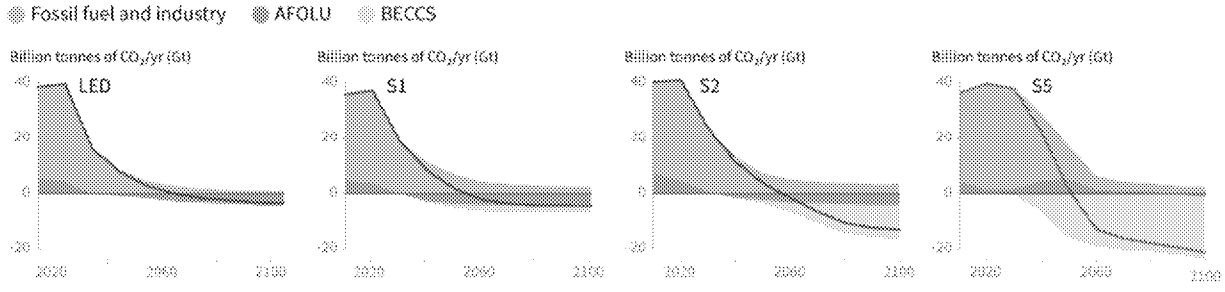


Figure SPM.3a: Global emissions characteristics of pathways. Four illustrative pathways are highlighted and labelled with LED, S1, S2, and S5 in the main panel. Descriptions and characteristics of these pathways are available in Figure SPM3b. Global net anthropogenic CO2 emissions in pathways limiting global warming to 1.5°C with no or limited overshoot and pathways with higher overshoot. Non-CO2 emissions ranges in the inset show the 5–95% (light shading) and interquartile (dark shading) ranges of pathways limiting global warming to 1.5°C with no or limited overshoot. Box and whiskers in the bottom panel show the timing of pathways reaching global net zero CO_2 emission levels, and a comparison with pathways limiting global warming to 2°C with at least 66% probability. {2.1, 2.2, 2.3, Figure 2.5, Figure 2.10, Figure 2.11}

Characteristics of four illustrative pathways

Different mitigation strategies can achieve the net emissions reductions that would be required to follow a pathway that limit global warming to 1.5°C with no or limited overshoot. For example, the amount of Carbon Dioxide Removal (CDR) varies across pathways, as do the relative contributions of Bioenergy with Carbon Capture and Storage (BECCS) and removals in the Agriculture, Forestry and Other Land Use (AFOLU) sector. This has implications for the emissions and several other pathway characteristics.

Breakdown of contributions to global net CO_2 emissions in four illustrative pathways



LED: A scenario in which social, business, and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A down-sized energy system enables rapid decarbonisation of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

S1: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

S2: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

S5: A resource and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

	LED	S1	S2	S5
Estimated overshoot of 1.5°C	No or less than 0.1°C	No or less than 0.1°C	Less than 0.1°C	Larger than 0.2°C
Kyoto-GHG emissions in 2030	24 $GtCO_2eq/yr$	25 $GtCO_2eq/yr$	33 $GtCO_2eq/yr$	47 $GtCO_2eq/yr$
Kyoto-GHG emissions in 2050	9 $GtCO_2eq/yr$	7 $GtCO_2eq/yr$	11 $GtCO_2eq/yr$	10 $GtCO_2eq/yr$
CO_2 emission change in 2030	-58 % rel to 2010	-49 % rel to 2010	-41 % rel to 2010	4 % rel to 2010
Final energy demand in 2030	305 EJ/yr	325 EJ/yr	424 EJ/yr	464 EJ/yr
Final energy demand in 2050	245 EJ/yr	349 EJ/yr	438 EJ/yr	512 EJ/yr
Renewable share of electricity in 2030	60 %	58 %	48 %	25 %
Renewable share of electricity in 2050	77 %	81 %	63 %	70 %
Primary energy from coal in 2030	-78 % rel to 2010	-61 % rel to 2010	-75 % rel to 2010	-59 % rel to 2010
Primary energy from coal in 2050	-97 % rel to 2010	-77 % rel to 2010	-73 % rel to 2010	-97 % rel to 2010
Cumulative BECCS until 2100	0 $GtCO_2$	151 $GtCO_2$	414 $GtCO_2$	1191 $GtCO_2$
Cumulative CCS until 2100	0 $GtCO_2$	348 $GtCO_2$	687 $GtCO_2$	1218 $GtCO_2$
Land-use CO_2 emissions in 2050	-1,7 $GtCO_2/yr$	-3,8 $GtCO_2/yr$	-2,3 $GtCO_2/yr$	5,2 $GtCO_2/yr$
Land footprint of bioenergy crops	22 Mha	93 Mha	283 Mha	724 Mha

Figure SPM.3b: Characteristics of four illustrative pathways in relation to global warming of 1.5°C introduced in Figure SPM3a. A breakdown of the global net anthropogenic CO_2 emissions into the contributions in terms of CO_2 emissions from fossil fuel and industry, agriculture, forestry and other land use (AFOLU), and bioenergy with carbon capture and storage (BECCS) for four illustrative pathways that show a range of potential mitigation approaches. Further characteristics for each of these pathways are listed below each pathway. {2.2, 2.3, 2.4, 2.5.3, Figure 2.5, Figure 2.10, Figure 2.11, Figure SPM3a}

C2. Pathways limiting global warming to 1.5°C would require rapid and far-reaching transitions in energy, land, urban and infrastructure, and industrial systems. These systems transitions are unprecedented in terms of scale, but not necessarily in terms of speed, and imply deep emissions reductions in all sectors and a wide portfolio of mitigation options (*high confidence*). {2.3, 2.4, 2.5, 4.2, 4.3, 4.5}

C2.1. Pathways that limit global warming to 1.5°C with no or limited overshoot are qualitatively similar to those for 2°C, but their system changes are more rapid and pronounced over the next two decades (*high confidence*). These rates of change have been observed in the past within specific sectors, technologies and spatial contexts, but there is no documented historic precedent for their scale (*medium confidence*). {2.3.3, 2.3.4, 2.4, 2.5, 4.2.1, 4.2.2, Cross-Chapter Box 11 in Chapter 4}

C2.2. In energy systems, pathways limiting global warming to 1.5°C with no or limited overshoot generally have lower energy demand, faster electrification of energy end use, a higher share of low-carbon energy sources (including renewables, nuclear and fossil fuel with carbon dioxide capture and storage (CCS)) compared to 2°C pathways, particularly before 2050 (*high confidence*). In 1.5°C pathways, renewables are projected to supply 50–65% (interquartile range) of primary energy and 70–85% of electricity (*high confidence*). The political, economic, social and technical feasibility of solar energy, wind energy and electricity storage technologies increased over the past few years (*high confidence*), [(Table SPM.2)] {2.4.1, 2.4.2, figure 2.1, table 2.6, table 2.7, Cross-Chapter Box 6 in Chapter 3, 4.2.1, 4.3.1, 4.3.3, 4.5.2}

C2.3. CO_2 emissions from industry in pathways limiting global warming to 1.5°C with no or limited overshoot are projected to be about 75-90% lower in 2050 relative to 2010, as compared to 50-80% for global warming of 2°C. Such reductions can be achieved through combinations of new and existing technologies and practices, including electrification, hydrogen, sustainable bio-based feedstocks, product substitution, and carbon capture, utilization and storage (CCUS). These options are technically proven but their large scale deployment limited by economic and institutional constraints. Emissions reductions by energy and process efficiency by themseleves are insufficient for 1.5°C pathways (*high confidence*). [(Table SPM.2)] {2.4.3, 4.2.1, 4.3.4, Table 4.1, Table 4.3, 4.3.4, 4.5.2}

C2.4. The urban and infrastructure system transition consistent with limiting global warming to 1.5°C with no or limited overshoot would imply changes in land and urban planning practices and deeper emissions reductions in transport and buildings compared to pathways that hold global warming below 2°C. Technical measures and options enabling deep emissions reductions include electrification and energy-efficiency. In pathways limiting global warming to 1.5°C with no or limited overshoot, the electricity share of demand in buildings would be about 55-75% in 2050 compared to 50-70% in 2050 for 2°C global warming. In the transport sector, the share of low-carbon final energy would rise from less than 5% in 2020 to about 35–65% in 2050 compared to 25–45% for 2°C global warming (*medium confidence*). Socio-cultural, institutional and economic barriers may inhibit these options (*high confidence*). [(Table SPM.2)] {2.3.4, 2.4.3, 4.2.1, Table 4.1, 4.3.3, 4.5.2}.

C2.5. Transitions in global and regional land use are found in all pathways limiting global warming to 1.5°C with no or limited overshoot, but their scale depends on the pursued mitigation portfolio. 50–800 million hectares of pasture and up to 500 million hectares of agricultural land for food and feed crops are converted into 100–700 million hectares of area for energy crops and forests. The change in forest area by 2050 relative to 2010 ranges from 100 million hectares reduction to 1,000 million hectares increase (*medium confidence*). Such

transitions would need to be supported by sustainable management of the various demands on land for human settlements and ecosystem services. Options include sustainable intensification of land use practices, ecosystem restoration and changes towards less resource-intensive diets. Such options are often limited by institutional, environmental and socio-cultural barriers, though careful design and implementation could enhance their acceptability (*medium confidence*). [(Table SPM.2)] {2.4.4, 4.3.2, 4.5.2, Cross-Chapter Box 7 in Chapter 3}

C3. All pathways that limit global warming to 1.5°C with limited or no overshoot use carbon dioxide removal (CDR) on the order of 100–1,000 $GtCO_2$ over the 21st century to compensate for residual emissions and, in most cases, achieve net negative emissions to return global warming to 1.5°C following a peak (*high confidence*). CDR deployment of several hundreds of $GtCO_2$ is subject to multiple feasibility and sustainability constraints (*high confidence*). Near-term emissions reductions and measures to lower energy and land demand can limit CDR deployment to a few hundred $GtCO_2$ without reliance on bioenergy with carbon capture and storage (BECCS) (*high confidence*). {2.3, 2.4, 3.6.2, 4.3, 5.4}

C3.1. Existing and potential CDR measures include afforestation and reforestation, land restoration and soil carbon sequestration, BECCS, direct air carbon capture and storage (DACCS), enhanced weathering and ocean alkalinization. These differ widely in terms of maturity, potentials, costs, risks, co-benefits and trade-offs (*high confidence*). To date, only a few published pathways include CDR measures other than afforestation and BECCS. {2.3.4, 3.6.2, 4.3.2, 4.3.7}

C3.2. In pathways limiting global warming to 1.5°C with limited or no overshoot, BECCS deployment ranges from 0-1, 0–8, and 0-16 $GtCO_2\ yr^{-1}$ in 2030, 2050, and 2100, respectively, while agriculture, forestry and land-use (AFOLU) related CDR measures remove 0-5, 1 –11, and 1-5 $GtCO_2\ yr^{-1}$ in these years (*medium confidence*). The upper end of these deployment ranges by mid-century exceeds the BECCS potential of up to 5 $GtCO_2\ yr^{-1}$ and afforestation potential of up to 3.6 $GtCO_2\ yr^{-1}$ assessed based on recent literature, indicating that such pathways may be impractical to achieve (*medium confidence*). Some pathways avoid BECCS deployment completely through demand-side measures and greater reliance on AFOLU-related CDR measures (*high confidence*). The use of bioenergy can be as high or even higher when BECCS is excluded compared to when it is included due to its potential for replacing fossil fuels across sectors (*high confidence*) (Figure SPM3) {2.3.3, 2.3.4, 2.4.2, 3.6.2, 4.3.1, 4.2.3, 4.3.2, 4.3.7, 4.4.3, Table 2.4}

C3.3. Pathways that overshoot 1.5°C of global warming rely on CDR exceeding residual CO_2 emissions later in the century to return to below 1.5°C by 2100, with larger overshoots requiring greater amounts of CDR (Figure SPM.3) (*high confidence*). Limitations on the speed, scale, and societal acceptability of CDR deployment hence govern the extent to which global warming can be returned to below 1.5°C following an overshoot. Carbon cycle and climate system understanding is still limited about the effectiveness of CDR to reduce temperatures after they peak (*high confidence*). [(Table SPM.2)] {2.2, 2.3.4, 2.3.5, 2.6, 4.3.7, 4.5.2, Table 4.11}

C3.4. Most current and potential CDR measures could have significant impacts on either land, energy, water, or nutrients if deployed at scale. Afforestation and bioenergy can compete with other land uses and could have significant impacts on agricultural and food systems, biodiversity and other ecosystem services (*high confidence*). Effective governance is needed to limit such trade-offs and ensure permanence of carbon removal in terrestrial, geological

and ocean reservoirs (*high confidence*). Feasibility and sustainability of CDR use could be enhanced by a portfolio of options deployed at substantial, but lesser scales, rather than a single option at very large scale (*high confidence*). (Figure SPM3, [Table SPM.2]) {2.3.4, 2.4.4, 2.5.3, 2.6, 3.6.2, 4.3.2, 4.3.7, 4.5.2, 5.4.1, 5.4.2; Cross-Chapter Boxes 7 and 8 in Chapter 3, Table 4.11, Table 5.3, Figure 5.3}

C3.5. Some AFOLU-related CDR measures such as restoration of natural ecosystems and soil carbon sequestration could provide co-benefits such as improved biodiversity, soil quality, and local food security. If deployed at large scale, they would require effective governance to conserve and protect land carbon stocks and other ecosystems services (*medium confidence*). (Figure SPM 4, [Table SPM.2]) {2.3.3, 2.3.4, 2.4.2, 2.4.4, 3.6.2, 5.4.1, Cross-Chapter Boxes 3 in Chapter 1 and 7 in Chapter 3, 4.3.2, 4.3.7, 4.4.1, 4.5.2, Table 2.4}

D. Strengthening the Global Response in the Context of Sustainable Development and Efforts to Eradicate Poverty

D1. The current Nationally Determined Contributions (NDCs) submitted under the Paris Agreement would lead to global greenhouse gas emissions[9] in 2030 of 52–58 $GtCO_2eq\ yr^{-1}$ (*medium confidence*). This trajectory would not limit global warming to 1.5°C, even if supplemented by very challenging increases in the scale and ambition of emissions reductions after 2030 (*high confidence*). Avoiding overshoot and reliance on future large-scale deployment of carbon dioxide removal (CDR) can only be achieved if global CO_2 emissions start to decline well before 2030 (*high confidence*). {1.2, 2.3, 3.3, 3.4, 4.2, 4.4, Cross-Chapter Box 11 in Chapter 4}

D1.1. Pathways that limit global warming to 1.5°C with no or limited overshoot show clear emission reductions by 2030 (*high confidence*). All but one show a decline in global greenhouse gas emissions to below 35 $GtCO_2eq\ yr^{-1}$ in 2030, and half of available pathways fall within the 25-30 $GtCO_2eq\ yr^{-1}$ range (interquartile range), a 40-50% reduction from 2010 levels. (*high confidence*). The current NDCs are broadly consistent with cost-effective pathways that result in a global warming of about 3°C by 2100, with warming continuing afterwards. (*medium confidence*). {2.3.3, 2.3.5, Cross-Chapter Box 11 in Chapter 4, 5.5.3.2}

D1.2. Overshoot trajectories result in higher impacts and associated challenges compared to pathways that limit global warming to 1.5°C with no or limited overshoot (*high confidence*). Reversing warming after an overshoot of 0.2°C or larger during this century would require upscaling and deployment of CDR at rates and volumes that might not be achievable given considerable implementation challenges (*medium confidence*) {1.3.3, 2.3.4, 2.3.5, 2.5.1, 3.3, 4.3.7, Cross-Chapter Box 8 in Chapter 3, Cross-Chapter Box 11 in Chapter 4}

D1.3. The lower the emissions in 2030, the lower the challenge in limiting global warming to 1.5°C after 2030 with no or limited overshoot (*high confidence*). The challenges from delayed actions to reduce greenhouse gas emissions include the risk of cost escalation, lock-in in carbon-emitting infrastructure, stranded assets, and reduced flexibility in future response options in the medium to long-term (*high confidence*). These may increase uneven distributional impacts between countries at different stages of development (*medium confidence*). {2.3.5, 4.4.5, 5.4.2}

[9] GHG emissions have been aggregated with 100-year GWP values as introduced in the IPCC Second Assessment Report

D2. Adaptation options specific to national contexts, if carefully selected together with enabling conditions, will have benefits for sustainable development and poverty reduction with global warming of 1.5°C (*high confidence*). {1.4, 4.3, 4.5, 5.3}

D2.1. Adaptation options that reduce the vulnerability of agriculture, urban and ecological systems have many synergies with sustainable development, such as ensuring food and water security, reducing disaster risks, improving health, maintaining ecosystem services and reducing poverty and inequality *(high confidence)*. Increasing investment in physical and social infrastructure is a key enabling condition to enhance the resilience and the adaptive capacities of societies. These benefits can occur in most regions with adaptation to 1.5°C of global warming *(high confidence)*. {1.4.3, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.5, 4.4.1, 4.4.3, 4.5.3, 5.3.1, 5.3.2}

D2.2. Adaptation to 1.5°C global warming can also result in trade–offs with adverse impacts for sustainable development if poorly designed and implemented. For example, adaptation projects that intensify agriculture or expand urban infrastructure can increase greenhouse gas emissions and water use, increase gender and social inequality, undermine health, and encroach on natural ecosystems *(high confidence)*. These trade-offs can be minimized by adaptation planning that includes attention to poverty and sustainable development implications. (*high confidence*) {4.3.2, 4.3.3, 4.5.4, 5.3.2; Cross-Chapter Boxes 6 and 7 in Chapter 3}

D2.3. A mix of adaptation and mitigation options to limit global warming to 1.5°C, implemented in a participatory and integrated manner, can enable rapid, systemic transitions in urban and rural areas (*high confidence*). These are most effective when aligned with economic and sustainable development, and when local and regional governments are supported by national governments (*medium confidence*) {4.3.2, 4.3.3, 4.4.1, 4.4.2}

D2.4. Adaptation options that also mitigate emissions can provide synergies and cost savings in most sectors and system transitions, such as when land management reduces emissions and disaster risk, or when low carbon buildings are also designed for efficient cooling. Trade-offs between mitigation and adaptation, when limiting global warming to 1.5°C, such as when bioenergy crops or reforestation encroach on land needed for agricultural adaptation, can undermine food security, livelihoods, ecosystem function and other aspects of sustainable development. (*high confidence*) {3.4.3, 4.3.2, 4.3.4, 4.4.1, 4.5.2, 4.5.3, 4.5.4}

D3. Mitigation options consistent with 1.5°C pathways are associated with multiple synergies and trade-offs across the Sustainable Development Goals (SDGs). While the total number of possible synergies exceeds the number of trade-offs, their net effect will depend on the pace and magnitude of changes, the composition of the mitigation portfolio and the management of the transition. *(high confidence)* (SPM Figure 4) {2.5, 4.5, 5.4}

D3.1. 1.5°C pathways have robust synergies particularly for the SDGs 3 (health), 7 (clean energy), 11 (cities and communities), 12 (responsible consumption and production), and 14 (oceans) (*very high confidence*). Some 1.5°C pathways show potential trade-offs with mitigation for SDGs 1 (poverty), 2 (hunger), 6 (water), and 7 (energy access), if not carefully managed (*high confidence*) (Figure SPM4). {5.4.2; Figure 5.4, Cross-Chapter Boxes 7 and 8 in Chapter 3}

D3.2. 1.5°C pathways that include low energy demand (for example the illustrative LED pathway in Figure SPM3a and b), low material consumption, and low GHG-intensive food consumption have the most pronounced synergies and the lowest number of trade-offs with respect to sustainable development and the SDGs (*high confidence*). Such pathways would reduce dependence on carbon dioxide removal (CDR) (*high confidence*). (Figure SPM4, Figure SPM3) {2.4.3, 2.5.1, 2.5.3, Figure 2.4, Figure 2.28, 5.4.1, 5.4.2, Figure 5.4}

D3.3. The impacts of land-based CDR and other land-intensive mitigation options on SDGs depend on the type of options and the scale of deployment (*high confidence*). If poorly implemented, options such as BECCS, bioenergy and AFOLU would lead to trade-offs. Context-relevant design and implementation requires considering people's needs, biodiversity, and other sustainable development dimensions (*very high confidence*). {4.3.7, 5.4.1.3, Cross-Chapter Box 7 in Chapter 3}

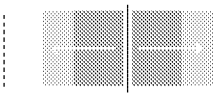
D3.4. Mitigation consistent with 1.5°C pathways creates risks for sustainable development in regions with high dependency on fossil fuels for revenue and employment generation (*high confidence*). Policies that promote diversification of the economy and the energy sector can address the associated challenges (*high confidence*). {5.4.1.2, Box 5.2}

D3.5. Redistributive policies across sectors and populations that shield the poor and vulnerable can resolve trade-offs for a range of SDGs, particularly hunger, poverty and energy access. Investment needs for such complementary policies are only a small fraction of the overall mitigation investments in 1.5°C pathways. (*high confidence*) {2.4.3, 5.4.2, Figure 5.5}

Possible synergies and trade-offs of climate change mitigation with the SDGs

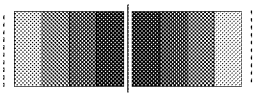
Mitigation options deployed in each sector can be associated with potential synergies or trade-offs with the Sustainable Development Goals (SDGs). The degree to which this potential is realized will depend on the selected portfolio of mitigation options, mitigation policy design, and local circumstances and context. Particularly in the energy-demand sector, the potential for synergies is larger than for trade-offs. The bars group individually assessed options by level of confidence and take into account the relative strength of the assessed mitigation-SDG connections.

Length shows strength of connection

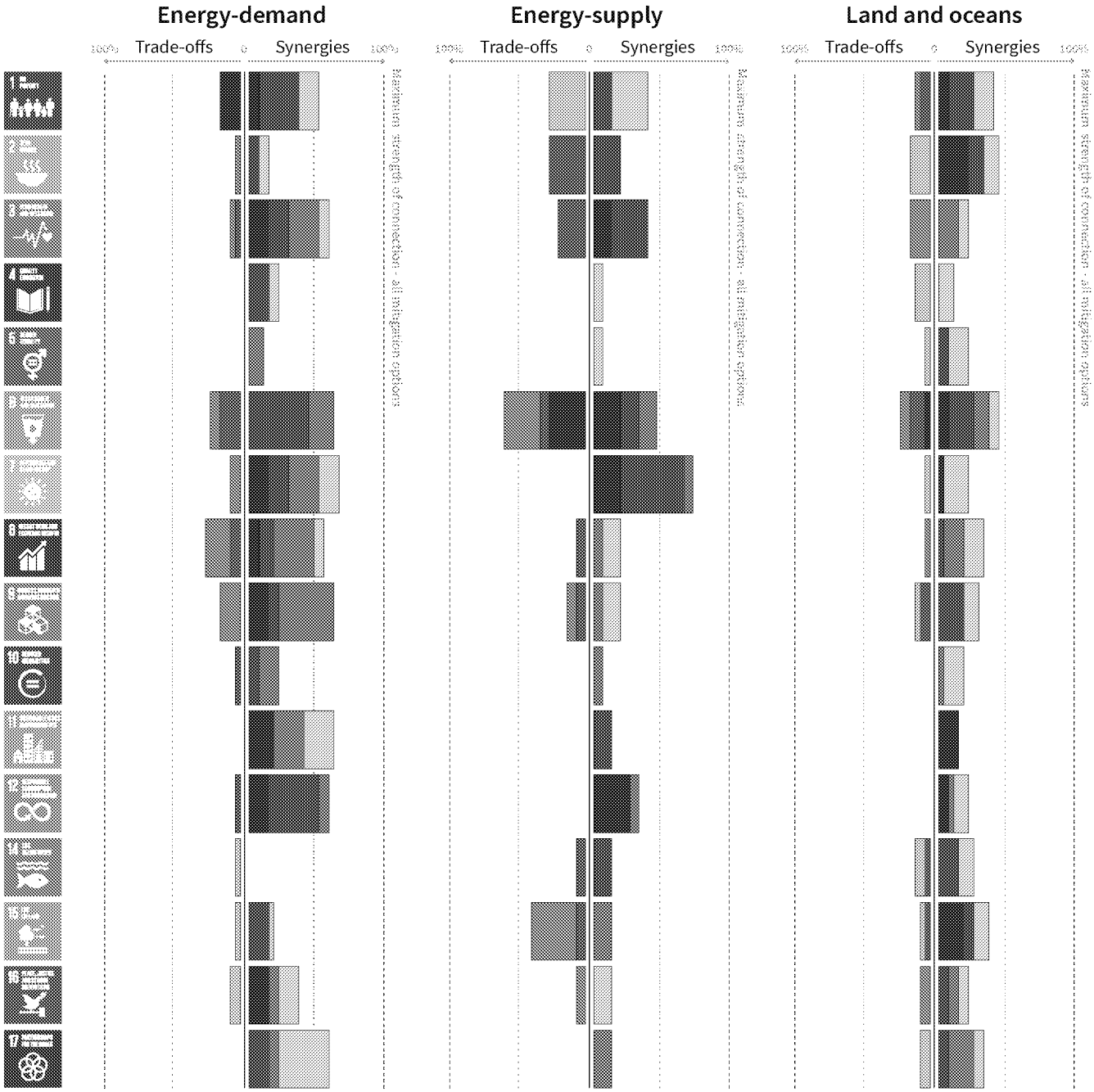


The overall **size of the coloured bars (from 0 to 100%)** depict **the relative potential** for synergies and trade-offs between the sectoral mitigation options and the SDGs.

Shades show level of confidence



The shades depict **the level of confidence** of the assessed potential.



[1]**SDG1:** No Poverty, **SDG2:** Zero Hunger, **SDG3:** Good Health and Well-being, **SDG4:** Quality Education, **SDG5:** Gender Equality, **SDG6:** Clean Water and Sanitation, **SDG7:** Affordable and Clean Energy, **SDG8:** Decent Work and Economic Growth, **SDG9:** Industry, Innovation and Infrastructure, **SDG10:** Reduced Inequality, **SDG11:** Sustainable Cities and Communities, **SDG12:** Responsible Consumption and Production, **SDG13:** Climate action is not included because we are considering how mitigation is interacting with SDGs and not vice versa **SDG14:** Life Below Water, **SDG15:** Life on Land, **SDG16:** Peace and Justice Strong Institutions, **SDG17:** Partnerships to achieve the Goal

Data source: Special Report on Global Warming of 1.5°C

Figure SPM.4: Potential synergies and trade-offs between the sectoral portfolio of climate change mitigation options and the Sustainable Development Goals (SDGs). The strength of the sectoral interactions is based on the assessment of individual mitigation options listed in Table 5.2, which assesses for each option the strength and direction of the interaction (synergy or trade-off) as well as the confidence of the underlying literature (shades of green and red). The effect of the individual options is aggregated to represent the total sectoral potential. A potential of 100% depicts a hypothetical case where the interaction of mitigation options in a sector and a specific SDG show maximum strength for all options assessed. The areas above the bars, which indicate no interactions, have *low confidence* due to the uncertainty and limited number of studies exploring indirect effects. The strength of the connection considers only the effect of mitigation and does not include benefits of avoided impacts. SDG 13 (climate action) is not listed because mitigation is being considered in terms of interactions with SDGs and not vice versa. Other approaches assessed in the ocean sector that remove CO_2 from the atmosphere include alkalinization and iron fertilization. {5.4, Table 5.2, Figure 5.2}

D4. Limiting the risks from global warming of 1.5°C in the context of sustainable development and poverty eradication implies system transitions that can be enabled by an increase of adaptation and mitigation investments, policy instruments, the acceleration of technological innovation and behaviour changes (*high confidence*). {2.3, 2.4, 2.5, 3.2, 4.2, 4.4, 4.5, 5.2, 5.5, 5.6}

D4.1. The redirection of world savings towards investment in infrastructure for mitigation and adaptation could provide additional resources. Redirected finance could involve the mobilization of private funds by institutional investors, asset managers and development or investment banks, as well as the application of public funds. Government policies that de-risk low-emission and adaptation investments can facilitate the mobilization of private funds and enhance the effectiveness of other public policies. (*high confidence*) {2.5.2, 4.4.5}

D4.2. Adaptation finance consistent with global warming of 1.5°C is difficult to quantify and compare with 2°C. Knowledge gaps include insufficient data to calculate specific climate resilience-enhancing investments, from the provision of currently underinvested basic infrastructure. Estimates of the costs of adaptation might be lower at global warming of 1.5°C than for 2°C, but would be higher than the USD 22.5 billion (2014) estimates of bilateral and multilateral funding for climate change adaptation (*medium confidence*). Currently, 18–25% of climate finance flows to adaptation in developing countries (*high confidence*) {4.4.5, 4.6}

D4.3. Pathways limiting global warming to 1.5°C with no or limited overshoot involve the redistribution of global investments in infrastructure. Average annual investment in low-carbon energy technologies and energy efficiency roughly doubles while investments in fossil fuel extraction and conversion decrease by about a quarter over the next two decades (*medium confidence*). Additional investment in infrastructure (energy, transportation, buildings, water and sanitation) would be required. Between 2015 and 2035, this investment is estimated to be on average 2.5% of annual economy-wide investment (0.6% of global GDP) (*medium confidence*). {2.5.2, 4.4.5, Box 4.8}

D4.4. Policy packages can help mobilise incremental resources and redirect global world savings through flexible mechanisms that integrate explicit carbon pricing, technology policies, performance standards, reduction of fossil fuel subsidies, de-risking of investments through innovative financial instruments, performance standards, other pricing policies (land, real estates) and compensating transfers to secure the equity of the transition. 1.5°C pathways show an average discounted global cost for the last ton of emissions reductions that is 3-4 times higher than in 2°C pathways across models. (*high confidence*) {1.3.3, 2.3.4, 2.3.5, 2.5.1, Cross-Chapter Box 8 in Chapter 3 and 11 in Chapter 4, 2.5.1, 2.5.2, 4.4.5, 5.5.2}

D4.5. The systems transitions consistent with adapting to and limiting global warming to 1.5°C include the widespread adoption of new and possibly disruptive technologies and

practices and enhanced climate-driven innovation. These imply enhanced technological innovation capabilities, including in industry and finance. Both national innovation policies and international cooperation can contribute to the development, commercialization and widespread adoption of mitigation and adaptation technologies. Innovation policies can be more effective when they combine support for research and development with incentives for market uptake in policy mixes. (*high confidence*) {4.4.4, 4.4.5}.

D4.6. Education, information, and community approaches, including those that are informed by Indigenous knowledge and local knowledge, can accelerate the wide scale behaviour changes consistent with adapting to and limiting global warming to 1.5°C. These approaches are more effective when combined with other policies and tailored to the motivations, capabilities, and resources of specific actors and contexts (*high confidence*). Public acceptability can enable or inhibit the implementation of policies and measures to limit global warming to 1.5°C and to adapt to the consequences. Public acceptability depends on the individual's evaluation of expected policy consequences, the perceived fairness of the distribution of these consequences, and perceived fairness of decision procedures (*high confidence*). {1.1, 1.5, 4.3.5, 4.4.1, 4.4.3, Box 4.3, 5.5.3, 5.6.5}

D5. Sustainable development supports, and often enables, the fundamental societal and systems transitions and transformations that help limit global warming to 1.5°C. Such changes facilitate the pursuit of climate-resilient development pathways that achieve ambitious mitigation and adaptation in conjunction with poverty eradication and efforts to reduce inequalities *(high confidence)*. {Box 1.1, 1.4.3, Figure 5.1, 5.5.3, Box 5.3}

D5.1. Social justice and equity are core aspects of climate-resilient development pathways that aim to limit global warming to 1.5°C as they address challenges and inevitable trade-offs, widen opportunities, and ensure that options, visions, and values are deliberated, between and within countries and communities, without making the poor and disadvantaged worse off (*high confidence*). {5.5.2, 5.5.3, Box 5.3, Figure 5.1, Figure 5.6, Cross-chapter Boxes 12 and 13 in Chapter 5}

D5.2. The potential for climate-resilient development pathways differs between and within regions and nations, due to different development contexts and starting points (*very high confidence*). Efforts along such pathways to date have been limited (medium confidence) and would require strengthened contributions from all countries and non-state actors without delay (*high confidence*). {5.5.1, 5.5.3, Figure 5.1}

D5.3. Pathways that are consistent with sustainable development show less mitigation and adaptation challenges and are associated with lower mitigation costs. The large majority of modelling studies could not construct pathways characterized by lack of cooperation, inequality and poverty that were able to limit global warming to 1.5°C. (*high confidence*) {2.3.1, 2.5.3, 5.5.2}

D6. Strengthening the capacities for climate action of national and sub-national authorities, civil society, the private sector, indigenous peoples and local communities can support the implementation of ambitious actions implied by limiting global warming to 1.5°C (*high confidence*). International cooperation can provide an enabling environment for this to be achieved in all countries and for all people, in the context of sustainable development (*high confidence*) {1.4, 2.3, 2.5, 4.2, 4.4, 4.5, 5.3, 5.4, 5.5, 5.6, 5, Box 4.1, Box 4.2, Box 4.7, Box 5.3, Cross-Chapter Box 9 in Chapter 4, Cross-Chapter Box 13 in Chapter 5}

D6.1. Partnerships involving non-state public and private actors, institutional investors, the banking system, civil society and scientific institutions would facilitate actions and responses consistent with limiting global warming to 1.5°C (*very high confidence*). {1.4, 4.4.1, 4.2.2, 4.4.3, 4.4.5, 4.5.3, 5.4.1, 5.6.2, Box 5.3}.

D6.2. Cooperation on strengthened multilevel governance, coordinated sectoral and cross-sectoral policies, gender responsive policies, innovative financing and cooperation on technology development and transfer can ensure participation, transparency, capacity building, and learning among different players (*high confidence*). {2.5.2, 4.2.2, 4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.5.3, Cross-Chapter Box 9 in Chapter 4, 5.3.1, 4.4.5, 5.5.3, Cross-Chapter Box 13 in Chapter 5, 5.6.1, 5.6.3}

D6.3. International cooperation can support the implementation of 1.5°C-consistent climate responses in developing countries and vulnerable regions, by enabling access to finance and technology and enhancing capacities that can complement domestic resources (*high confidence*). {2.3.1, 4.4.1, 4.4.2, 4.4.4, 4.4.5, 5.4.1 5.5.3, 5.6.1, Box 4.1, Box 4.2, Box 4.7}.

D6.4. Collective efforts in the pursuit of limiting global warming to 1.5°C can facilitate strengthening the global response to climate change, achieving sustainable development and eradicating poverty *(high confidence).* {1.4.2, 2.3.1, 2.5.2, 4.2.2, 4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5, 4.5.3, 5.3.1, 5.4.1, 5.5.3, 5.6.1, 5.6.2, 5.6.3}

Box SPM 1: Core Concepts Central to this Special Report

Global mean surface temperature (GMST): Estimated global average of near-surface air temperatures over land and sea-ice, and sea surface temperatures over ice-free ocean regions, normally expressed as departures from a specified reference period. Projected future changes in GMST are approximated by changes in global surface air temperature.[10] {1.2.1.1}

Pre-industrial: The multi-century period prior to the onset of large-scale industrial activity around 1750. The reference period 1850–1900 is used to approximate pre-industrial GMST. {1.2.1.2}

Global warming: The estimated increase in GMST averaged over a 30-year period, or the 30-year period centered on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified. For 30-year periods that span past and future years, the current warming trend is assumed to continue. {1.2.1}

Net zero CO_2 emissions: Conditions in which anthropogenic carbon dioxide (CO_2) emissions are approximately balanced globally by anthropogenic CO_2 removals.

Carbon dioxide removal (CDR): Anthropogenic activities removing CO_2 from the atmosphere and transferring it to geological, terrestrial, product or ocean storage. It includes anthropogenic enhancement of biological or geochemical sinks and direct chemical air capture and storage, but excludes natural CO_2 sinks.

Remaining carbon budget: Cumulative net global anthropogenic CO_2 emissions from the start of 2018 to the time that anthropogenic CO_2 emissions reach net zero that would result, at some probability, in limiting global warming to a given level, accounting for the impact of other anthropogenic emissions. The total carbon budget is the sum of historical CO_2 emissions and the remaining carbon budget. {2.2.2}

Temperature overshoot: The temporary exceedance of a specified level of global warming, returning to that level before 2100 through CDR and/or reductions in emissions of other greenhouse gases. {1.2.3, 1.2.3.2}

Pathway: The trajectory of natural and/or human systems towards a future state. Emission pathways are classified by their temperature trajectory over the 21st century: pathways giving at least 50% probability based on current knowledge of limiting global warming to below 1.5°C are classified as 'no overshoot'; those limiting warming to below 1.6°C and returning to 1.5°C by 2100 are classified as '1.5°C limited-overshoot'; while those exceeding 1.6°C but still returning to 1.5°C by 2100 are classified as 'higher-overshoot'.

Impacts: Effects of climate change, such as warming, sea level rise or changes in the frequency and intensity of heat waves or precipitation events, on human and natural systems. Impacts can have beneficial or adverse outcomes for livelihoods, health and well-being, ecosystems and species, services, infrastructure, and economic, social and cultural assets.

Risk: The potential for adverse consequences from a climate-related hazard for human and natural systems, resulting from the interactions between the hazard and the vulnerability and exposure of the affected system. Risk integrates the likelihood of exposure to a hazard and the

[10] Past IPCC reports, reflecting the literature, have used a variety of global mean surface temperature metrics for observed warming, temperature projections, impacts and carbon budgets calculations both within and across Working Group reports.

magnitude of its impact. Risk also can describe the potential for adverse consequences of adaptation or mitigation responses to climate change.

Climate-resilient development pathways (CRDPs): Trajectories that strengthen sustainable development and efforts to eradicate poverty through equitable societal transformations across all scales and economies, while reducing the threat of climate change through ambitious mitigation, adaptation, and climate resilience {1.4.3, Cross-Chapter Box 1 in Chapter 1, 5.1, Figure 5.1, 5.5.3}

[Table SPM.1: Adaptation feasibility table. Feasibility assessment of examples of adaptation options relevant to 1.5°C of global warming with dark shading signifying the absence of barriers in the feasibility dimension, moderate shading that the dimension does not have a positive or negative effect on the feasibility of the option, and light shading the presence of potentially blocking barriers. No shading means that not sufficient literature could be found to make the assessment. {Table 4.12}]

	Adaptation option	Confidence	Economic	Technological	Institutional	Socio-cultural	Environmental-ecological	Geophysical	Context
Land and Ecosystem Transitions	Conservation agriculture	Medium							Depends on irrigated/rain-fed system, ecosystem characteristics, crop type, other farming practices
	Efficient irrigation	Medium							Depends on agricultural system, technology used, regional institutional and biophysical context
	Efficient livestock systems	Medium							Dependent on livestock breeds, feed practices, and biophysical context (e.g. carrying capacity)
	Community-based adaptation	Medium							Focus on rural areas and combined with ecosystems-based adaptation, does not include urban settings
	Ecosystem restoration & avoided deforestation	High							Mostly focused on existing and evaluated Reducing Emissions from Deforestation and Forest Degradation (REDD+) projects
	Coastal defence & hardening	High							Depends on locations that require it as a first adaptation option
Urban and Infrastructure System Transitions	Sustainable land-use & urban planning	Medium							Depends on nature of planning systems and enforcement mechanisms
	Sustainable water management	High							Balancing sustainable water supply and rising demand especially
	Green infrastructure & ecosystem services	High							Depends on reconciliation of urban development with green infrastructure

[Table SPM.2: Feasibility assessment of examples of mitigation options relevant to 1.5°C global warming and illustrative pathways in Figure SPM3a and b. Dark shading signifies the absence of barriers in the feasibility dimension, moderate shading that on average, the dimension does not have a positive or negative effect on the feasibility of the option, and faint shading the presence of potentially blocking barriers. No shading means that not sufficient literature could be found to make the assessment. Evidence and agreement assessment is undertaken at the option level. The context column on the far right indicates how the assessment might change as a consequence of contextual factors. {Table 4.11}]

	Mitigation Option	Confidence	Economic	Technological	Institutional	Socio-cultural	Environmental-ecological	Geophysical	Context
Energy System Transitions	Solar PV	High							Cost-effectiveness affected by solar irradiation and incentive regime. Also enhanced by legal framework for independent power producers, which affects uptake.
	Power sector CCS	High							Varies with local CO_2 storage capacity, presence of legal framework, level of development and quality of public engagement
Land and Ecosystem Transitions	Ecosystems restoration	High							Depends on location and institutional factors
Urban and Infrastructure System Transitions	Electric cars and buses	Medium							Varies with degree of government intervention; requires capacity to retrofit 'fuelling' stations
	Non-motorized transport	High							Viability rests on linkages with public transport, cultural factors, climate and geography
	Low/zero-energy buildings	High							Depends on size of existing building stock and growth of building stock
Industrial System Transitions	Energy efficiency	High							Potential and adoption depend on existing efficiency, energy prices and interest rates, as well as government incentives.
	Industrial CCUS	High							High concentration of CO_2 in exhaust gas improve economic and technical feasibility of CCUS in industry. CO_2 storage or reuse possibilities.
Carbon Dioxide Removal	BECCS	Medium							Depends on biomass availability, CO_2 storage capacity, legal framework, economic status and social acceptance
	Afforestation & reforestation	High							Depends on location, mode of implementation, and economic and institutional factors

Message

From: Stephen Gray [sgray@usgs.gov]
Sent: 10/10/2018 5:28:49 PM
To: Akhtar, Farhan H [AkhtarFH@state.gov]
CC: Haxthausen, Eric M. (E3/GCC/PEL) [ehaxthausen@usaid.gov]; Alpert, Alice [AlpertA@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Talley, Trigg [TalleyT@state.gov]; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]
Subject: Re: [EXTERNAL] RE: SR1.5 draft summary

Team USA-

I'm back on travel and away from my IPCC notes. So, sending this out to the entire group in hopes that you can help fill-in any memory gaps. With respect to the physical basis and impacts sections, I'd say that key US contributions included:

-The US Delegation was instrumental in ensuring that clear, consistent baselines were used throughout. Similarly, we insisted on appropriate date ranges, and that uncertainty ranges be inserted or modified as needed.

-We pushed for clarity in discussions of when observed temperature milestones had been reached (eg, 2017 as "year when 1C was surpassed vs decadal averages)

-We played a key role in efforts to better depict uncertainties in projections for crossing future temperature thresholds (eg, addition of orange "error bar" in FigSPM1)

-Initially discussions of sea level focused heavily on scenarios of multi-meter SLR after 2100. The US Delegation was key in redirecting text on SLR to focus on questions directly related to 1.5C.

-The original SPM text called out multiple examples of impacts that were not necessarily supported by the underlying science, or were only supported at lower levels of confidence. In cooperation with several other delegations, the US worked to ensure that the SPM called out specific examples associated with high confidence, or at least medium confidence with broad support in the literature.

Best,

Steve

Sent from my iPhone

On Oct 10, 2018, at 7:16 AM, Akhtar, Farhan H <AkhtarFH@state.gov> wrote:

> Thanks everyone. We've used this information in a couple of memos so far. **One final tasking:** we need to go through and highlight where edits were made in response to our comments on the FGD and during the meeting last week. Allen, in particular, it would be good to get information on how costs and the scale of the challenge are now reflected. Eric, it would be also helpful to have a clear message on how the SDGs treatment improved. Alice and Steve, on impacts, let's find a few examples where the uncertainty in the models were clarified.
>
> Please send in notes by tomorrow afternoon, please.
>
> Thanks again,
> Farhan
>
> **From:** Eric Haxthausen <ehaxthausen@usaid.gov>
> **Sent:** Tuesday, October 9, 2018 12:44 AM
> **To:** Alpert, Alice <AlpertA@state.gov>
> **Cc:** Akhtar, Farhan H <AkhtarFH@state.gov>; Fawcett, Allen <Fawcett.Allen@epa.gov>; Stephen Gray <sgray@usgs.gov>; Talley, Trigg <TalleyT@state.gov>; Benjamin DeAngelo - NOAA Federal <ben.deangelo@noaa.gov>
> **Subject:** SR1.5 draft summary
>
> Thanks, Alice. I'd defer to Trigg on how to characterize the feasibility point. Perhaps better to keep it factual, e.g: "the pace and scale of changes needed to limit warming to 1.5C suggest it is highly unlikely that temperatures could be limited to this level absent credible commitments from nearly all relevant actors to profound changes in energy supply and use."
>
> I'm not sure about the statement about bioenergy crops. The highest projection of bioenergy land use in Fig SPM.3b is 724Mha, whereas the land area of the United States is about 941 Mha.
>
> Best,
> Eric
>
> On Monday, October 8, 2018, Alpert, Alice <AlpertA@state.gov> wrote:
>
> > Thanks a lot for your feedback, Eric. I've revised the attached.
> >
> > I'm wondering if it would be appropriate to add something along the lines of "In (my) expert opinion, it is virtually certain that warming will not be limited to 1.5C, based on the rate and scale of changes implied."
> >
> > On Tue, Oct 9, 2018 at 7:49 AM Alpert, Alice <AlpertA@state.gov> wrote:
> >
> > **From:** Eric Haxthausen <ehaxthausen@usaid.gov>
> > **Sent:** Monday, October 8, 2018 9:51 PM
> > **To:** Alpert, Alice
> > **Cc:** Akhtar, Farhan H; Fawcett, Allen; Stephen Gray; Talley, Trigg

Subject: SR1.5 draft summary

Hi Alice,
Thanks for this. Some additional points to consider below, space depending. We would be interested in seeing the final memo and annex (redacted if necessary) to share with our leadership.

Best,
Eric

Impacts:

-may be worth mentioning the Arctic sea ice conclusions in b4.1.
Also may be worth noting that:

Arctic ecosystems, dryland regions, small islands, and the least developed countries face the greatest risk of impacts.

- Warming from 1.5 to 2 degrees would mean greater health risks associated with extreme heat and an expanded range of some vector-borne diseases, and greater reductions in yields of many staple crops, particularly at low latitudes.

Note that the low confidence statement doesn't apply to corals, which is a high confidence finding, or to the points above.

Pathways

Suggest rephrasing the first point to refer to "estimated emissions associated with NDCs submitted under the Paris Agreement." Arguably the ambition of the PA would be the temperature target(s) themselves.

- Suggest adding a parenthetical "as compared to 2075 for 2degC pathways" following the reference to net-zero by 2050.

Suggest moving up the penultimate point re "Pathways limiting global warming to 1.5°C would require rapid and far-reaching transitions in energy, land, urban, infrastructure, and industrial systems at unprecedented scale" to the 2nd or 3rd point in this section.

- Re coal - it may be more accurate to say that by 2050, the use of coal would drop by roughly 75% under some pathways and virtually cease under others. Can we elucidate why some pathways allow it and others don't?

Note that BECCS is Bioenergy *with* ccs

- Also worth noting:

>>Reducing energy demand (e.g. through improved efficiencies) increases the likelihood and reduces the cost of achieving 1.5 and 2 degree scenarios. Planting forests and bioenergy crops can play a significant role in 1.5 degree pathways, but could necessitate global shifts in land use spanning millions of square miles

- >>The report does not meaningfully assess geoengineering measures focused in changing the absorption of incoming solar radiation.

On Sunday, October 7, 2018, Alpert, Alice <AlpertA@state.gov> wrote:

> Hello team,
>
> Please review this draft 1pg summary of SR1.5 findings, with some questions and comments.
>
> This is intended as a factual appendix to a memo describing the meeting and report context.
>
> Alice

--

Eric Haxthausen
Senior Advisor
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Bureau for Economic Growth, Education, and Environment
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--

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Official
UNCLASSIFIED

Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 10/23/2018 4:08:04 PM
To: ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]
CC: Talley, Trigg [TalleyT@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Akhtar, Farhan H [AkhtarFH@state.gov]; Gray, Stephen [sgray@usgs.gov]; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]
Subject: Re: FW: Urgent - Consideration of corrections in the SPM of SR15

Hi Alice,

I have no substantive comments, as these are all related to Section C and SPM Figure 3, on which Allen was leading. However, it does seem to me that the first two corrections (pasted below) are also quite substantive, as these relate to some of the major conclusions of the report. Also, re the fourth correction -- I find the proposed rewording almost incomprehensible. I'm guessing that others will want to negotiate it further.

P18 – Section C1. – line 4: 20% should be changed to 25%
P18 – Section C1. – line 5: 2075 should be changed to 2070
P21 – C2.3 – Replace "75" with "65"

Approved Bullet: C2.5. Transitions in global and regional land use are found in all pathways limiting global warming to 1.5°C with no or limited overshoot, but their scale depends on the pursued mitigation portfolio. Model pathways that limit global warming to 1.5°C with no or limited overshoot project the conversion of 0.5–8 million km2 of pasture and 0–5 million km2 of non-pasture agricultural land for food and feed crops into 1–7 million km2 for energy crops and a 1 million km2 reduction to 10 million km2 increase in forests by 2050 relative to 2010 (medium confidence). Land-use transitions of similar magnitude can be observed in modelled 2°C pathways (medium confidence). Such large transitions pose profound challenges for sustainable management of the various demands on land for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services (high confidence). Mitigation options limiting the demand for land include sustainable intensification of land-use practices, ecosystem restoration and changes towards less resourceintensive diets (high confidence). The implementation of land-based mitigation options would require overcoming socioeconomic, institutional, technological, financing and environmental barriers that differ across regions (high confidence). {2.4.4, Figure 2.24, 4.3.2, 4.5.2, Cross-Chapter Box 7 in Chapter 3}

Corrected Bullet: C2.5. Transitions in global and regional land use are found in all pathways limiting global warming to 1.5°C with no or limited overshoot, but their scale depends on the pursued mitigation portfolio. Model pathways that limit global warming to 1.5°C with no or limited overshoot project a 0.5-11 million km2 reduction of pasture land, a 4 million km2 reduction to a 2.5 million km2 increase of nonpasture agricultural land for food and feed crops, a 0-6 million km2 increase of agricultural land for energy crops and a 2 million km2 reduction to 9.5 million km2 increase in forests by 2050 relative to 2010 (medium confidence). Land use transitions of similar magnitude can be observed in modelled 2°C pathways (medium confidence). Such large transitions pose profound challenges for sustainable management of the various demands on land for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services (high confidence). Mitigation options limiting the demand for land include . . . .

best,
Eric

Eric Haxthausen
Senior Advisor
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On Mon, Oct 22, 2018 at 4:34 PM Alpert, Alice <AlpertA@state.gov> wrote:

Hello all, please take a look at the attached proposed corrections to the SPM.

The most substantive change is pasted below.

- "energy related *mitigation* investment" on the left versus all "energy-related investments" on the right

- And "*...corresponds* to...annual average energy *demand* investments..." on the left versus "*...compares* to...average energy *supply* investments..."

Allen, does this make sense? Also attaching the approved SPM for context

Approved Bullet:

C2.6 Total annual average energy-related mitigation investment for the period 2015 to 2050 in pathways limiting warming to 1.5°C is estimated to be around 900 billion USD2015 (range of 180 billion to 1800 billion USD2015 across six models[17]). This corresponds to total annual average energy supply investments of 1600 to 3800 billion USD2015 and total annual average energy demand investments of 700 to 1000 billion USD2015 for the period 2015 to 2050, and an increase in total energy-related

Corrected Bullet:

C2.6 Additional annual average energy-related investments for the period 2016 to 2050 in pathways limiting warming to 1.5°C compared to pathways without new climate policies beyond those in place today are estimated to be around 830 billion USD2010 (range of 150 billion to 1700 billion USD2010 across six models[17]). This compares to total annual average energy supply investments in 1.5°C pathways of 1460 to 3510 billion USD2010 and total annual average energy demand

From: jfernandez@wmo.int <jfernandez@wmo.int> **On Behalf Of** IPCC-Sec IPCC-Sec
Sent: Monday, October 22, 2018 10:17 AM
To: IPCC-Sec IPCC-Sec <IPCC-Sec@wmo.int>
Subject: Urgent - Consideration of corrections in the SPM of SR15

To designated IPCC Focal Points and Ministries of Foreign Affairs

(if no focal point has been designated)

Dear Sir/Madam,

Please find attached the letter No. 5313-18/IPCC/SR15 regarding some corrections required for the Summary for Policymakers of the IPCC Special Report on Global Warming of 1.5°C, which was approved at the 1st Joint Session of Working Groups I, II and III, and accepted at the 48th Session of the IPCC, in Incheon, in October 2018.

We would be grateful for your urgent agreement with delegating the approval of the attached corrections in the Summary for Policymakers of the IPCC Special Report on Global Warming of 1.5°C to the Executive Committee.

If we do not hear from you by Friday 26 October 2018, 10:00 a.m. Geneva time, we take it that you agree with the proposed rapid response procedure.

Thank you.

Yours sincerely,

Joelle

For the Secretary of the IPCC

--

IPCC Secretariat
WMO
7bis, Avenue de la Paix
P.O. Box 2300
1211 Geneva 2
SWITZERLAND
Tel: +41 22 730 8208/8254/8284
Fax: +41 22 730 8025/8013

Email: IPCC-Sec@wmo.int
Website: http://www.ipcc.ch

Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/18/2018 4:00:08 PM
To: Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]
CC: ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]; sgray@usgs.gov; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; David Dokken (Contractor) [ddokken@usgcrp.gov]
Subject: Re: reminder: IPCC 48 papers by Wed Sept 19
Attachments: B5 (eh 091418) BJD eh091818.docx

Ben,

Thanks for this. I have a few more comments on B5; it will need some further work. I anticipate that the discussion around the relative economic impacts of 1.5 and 2 degrees (B5 and B5.5) will be one of the more hotly contested issues.

Also note that some of our U.S. comments on B3 (on ocean ecosystems) ended up in the B5 section due to a mistake in the page number (SPM-9 vs SPM-10).

best,
Eric

Eric Haxthausen
Senior Advisor
Global Climate Change Office
Bureau for Economic Growth, Education, and Environment
USAID

ehaxthausen@usaid.gov
+1 (202) 216-3263 (office)
+1 (202) 550-3343 (mobile)

On Tue, Sep 18, 2018 at 2:22 AM Benjamin DeAngelo - NOAA Federal <ben.deangelo@noaa.gov> wrote:

> Here are my contributions so far. The more I worked on these the more I focused on the main text and not the underlying comments and rationale. I'd caution against having too much supplemental info beyond the main text if you want these to be useful while you're in plenary.
>
> -Ben
>
> On Mon, Sep 17, 2018 at 10:44 AM, Alpert, Alice <AlpertA@state.gov> wrote:
>
> > Good morning experts,

Please let me know if you will have any trouble submitting strategies on the SPM statements assigned to you by this Wednesday. We are in final preparations for briefing up and are counting on your expert input. Thank you again and let me know if you have any questions.

Alice

Official

UNCLASSIFIED

From: Alpert, Alice
Sent: Thursday, September 13, 2018 6:15 PM
To: Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Fawcett, Allen' <Fawcett.Allen@epa.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: 'David Dokken' <ddokken@usgcrp.gov>
Subject: RE: IPCC 48 preparations

Hello team,

This is a reminder to continue preparing for the IPCC meeting in October. Please do not hesitate to reach with any questions you have.

I am attaching the consolidated comments submitted to the IPCC from governments. These will be important to look at carefully because they will be the best way to anticipate the changes to the next iteration of the SPM. Countries that do not see their changes in the next draft may make additions from the floor as well.

I will schedule a call the week of September 24 to make sure we are all prepared for the meeting. (Ben, let's connect next week before you leave)

All the best,

Alice

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From: Alpert, Alice
Sent: Friday, August 31, 2018 4:28 AM
To: Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Fawcett, Allen' <Fawcett.Allen@epa.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>
Subject: IPCC 48 preparations

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acceptable fallback options based on the underlying chapter. Please add the alternate text and references to the underlying chapter, as appropriate, to the specific heading document.

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A5: Eric and Farhan with Allen

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B6: Eric and Farhan

Figure 2: Ben, Eric, Farhan

C1: Allen (with Farhan on C1.2)

C2: Allen and Eric

C3: Allen and Eric

Figure 3: Allen

Figure 4: Farhan

D1: Allen

D2: Farhan and Eric

D3: Farhan and Eric

D4: Eric and Allen

D5: Farhan and Eric

D6: Farhan and Eric

Official

UNCLASSIFIED

--

Benjamin DeAngelo
Deputy Director
NOAA Climate Program Office
cpo.noaa.gov

301-734-1093 office
240-750-8243 cell
ben.deangelo@noaa.gov

Message

From: Alpert, Alice [AlpertA@state.gov]
Sent: 10/23/2018 3:49:37 PM
To: jae@pnnl.gov; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
CC: Matza, Helaina R [MatzaHR@state.gov]; Jaeger, Joel M [JaegerJM@state.gov]
Subject: guiding questions for tomorrow's call on global stocktake
Attachments: Paris_Agreement_final.pdf

Hello Jae and Allen,

Thank you again for taking the time to chat with me tomorrow. Below are some guiding questions that I would appreciate your take on:

- How do you envision scientific literature informing the global stocktake? Ie, would a formal process be valuable?
- Do you see any lessons learned from the Talanoa Dialogue process for the UNFCCC and/or IPCC?
- What content areas from IPCC products do you see as primarily informing the global stocktake?
- What do you see as an effective process for IPCC products to inform the global stocktake? Ie, would a formal process be valuable?
- Do you see the necessity for a specialized IPCC product to inform the global stocktake?

To refresh your memory I am attaching the Paris Agreement and associated COP21 decision. The key sections for the global stocktake are paragraphs 99-101 of the decision and article 14 of the Agreement. Below is my rough sketch of IPCC cycles and global stocktakes for the next couple of decades.

Year	7 year cycles	6 year cycles
2017		
2018	Talanoa/SR1.5	Talanoa/SR1.5
2019		
2020		
2021	AR6	AR6
2022	GST 1	GST 1
2023		
2024		
2025		
2026		
2027	GST 2/ AR7	GST 2/ AR7
2028		
2029		
2030		
2031		
2032	GST 3	GST 3/AR8
2033		
2034		
2035	AR8	

2036		
2037	GST 4	GST 4
2038		
2039		AR9
2040		
2041		
2042	GST 5/AR9	GST 5/AR9
2043		

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Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/5/2018 9:33:36 PM
To: ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]
CC: Akhtar, Farhan H [AkhtarFH@state.gov]; sgray@usgs.gov; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]; David Dokken (Contractor) [ddokken@usgcrp.gov]
Subject: Re: IPCC 48 preparations

Thanks, Alice.

I am also wondering if it might be helpful for a couple people to take the lead on the definitions section, perhaps Ben and Allen?

best,
Eric

Eric Haxthausen
Senior Advisor
Global Climate Change Office
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On Sat, Sep 1, 2018 at 1:56 AM Alpert, Alice <AlpertA@state.gov> wrote:

> Hello Expert team,
>
> I am attaching the document for statement D6 here, most relevant for Eric and Farhan. (thanks for the catch, Eric)
>
> Please note also that for other statements some comments are highlighted in yellow, we can further discuss our approach to these.
>
> Also note that in the "whole SPM comments" document I included some comments we submitted in July related to specific text in the underlying chapters because they contain useful points and arguments to draw from in your preparation.

Please let me know if you have any additional questions or need further clarification.

Best,

Alice

Official

UNCLASSIFIED

From: Alpert, Alice
Sent: Friday, August 31, 2018 3:28 PM
To: Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Fawcett, Allen' <Fawcett.Allen@epa.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>
Subject: IPCC 48 preparations

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D1: Allen

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D5: Farhan and Eric

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Official

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Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/18/2018 2:45:31 PM
To: ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]
CC: Akhtar, Farhan H [AkhtarFH@state.gov]; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]; sgray@usgs.gov; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Talley, Trigg [TalleyT@state.gov]; David Dokken (Contractor) [ddokken@usgcrp.gov]
Subject: Re: expert comm. call Tues 2:30EDT

Hi Alice and all,

in preparation for today's call, I jotted down some notes reflecting my speculation about what might be the public narrative, based on close observation of how previous assessment reports were covered. Of course this may vary a bit from country to country or region to region. Some of this will play out at the meeting (e.g. #3) and immediately after (#1-4), some of it will play out over the coming months (#2, #4, #5).

Others may wish to add to specific points.

Look forward to talking at 2:30.

best,
Eric

1) Substance of the report

- The report finds that the Earth has now warmed by X degrees, and that scientists are confident that we are already seeing [list] impacts of climate change. (+ narrative link to recent climate/weather news stories - tropical cyclones, fires, heatwaves, droughts, etc.)
- By holding warming to 1.5 degrees, the report finds that the world could avoid certain predicted impacts of climate change that may occur at the internationally agreed goal of 2 degrees, e.g., [with details as provided in SPM] coral bleaching, ice-free Arctic, crop yields, extinction, permafrost loss. - also SLR and coastal pop at risk
- implications for SIDS?
- Even at 1.5 degrees, the report finds that ....

- The report also examines what would be necessary to limit warming to 1.5 degrees. It finds that . . . [depends on final presentation in SPM]. For example, . . . [some sector by sector numbers or statements from C3, perhaps muddled due to poor communication in the SPM and lack of technical understanding of reporters. This might include some limited discussion of CDR - and SRM?)]
- Discussion of whether this is feasible, drawing on the report but also on interivews with environmental advocates and other technical experts, including from industry, and possibly interviews with negotiators or key international public figures (UN SG, UNFCCC director, IEA, etc.).
- Discussion of the relationship to Paris Agreement and existing policy. US progress and impact of US stance (in US, other domestic audiences focus internally as well or to greater extent).

2) secondary topics
- Discussion (mainly in financial press) of the recent growth in the RE market and declining cost curve.

- Possible discussion in US press of carbon tax advocacy effort and impact of state and local initiatives recently showcased at Calif summit
- Possibly some discussion of tradeoffs between CCS/CDR and other mitigation strategies, including interviews with environmental advocates.
- possibly some passing mention of SDGs but more an issue for non-US audiences.

3) Negotiation and diplomatic/political dynamics and inside game
- How the major players are reacting. (e.g., US, China, India, SIDS, G77, EU/Germany/France, Japan) What maneuvering went on behind the scenes
- How the report changed from leaked drafts (and speculation about why)

4) Implications
- Tie in to upcoming COP and state of negotiations. US leaving Paris. Progress on implementing Paris or lack thereof.
- How are other countries positioning themselves vis a vis 1.5 or 2 degrees? Are there any jurisdictions that are aiming for 1.5 degrees? Possible interviews of different camps (SIDS and jurisdictions aiming for 1.5 vs others saying it's too hard).

5) Further analysis
- corporate engagement - how does it relate to 1.5?
- Attempt to tell impacts story for local audiences: What would 1.5 vs 2 mean for various local areas? for hurricane strength, coastal flooding, etc.

Eric Haxthausen
Senior Advisor
Global Climate Change Office
Bureau for Economic Growth, Education, and Environment
USAID

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On Mon, Sep 17, 2018 at 1:05 PM Alpert, Alice <AlpertA@state.gov> wrote:

> Hello expert committee,
>
> The Dept of State team would like to touch base with you tomorrow at 2:30 EDT regarding the upcoming IPCC meeting as we prepare for upcoming briefings. Trigg Talley, who will head the delegation in Korea would like to hear about the expected public narrative regarding the report. Please also be prepared to describe any major problems you see in your respective chapters of the underlying report. If you are unable to join the call, please send your relevant remarks via email.

We appreciate your flexibility on short notice, and thank you again for all your hard work.

Best,

Alice

Official

UNCLASSIFIED

Message

From: Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]
Sent: 9/18/2018 6:20:07 AM
To: Alpert, Alice [AlpertA@state.gov]
CC: Akhtar, Farhan H [AkhtarFH@state.gov]; Haxthausen, Eric M. (E3/GCC/PEL) [ehaxthausen@usaid.gov]; Gray, Stephen [sgray@usgs.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; David Dokken [ddokken@usgcrp.gov]
Subject: Re: reminder: IPCC 48 papers by Wed Sept 19
Attachments: US_toplines_SR15_20180822 BJD.docx; B4 BJD.docx; B3 BJD.docx; A3 (eh 091018) bjd_eh091418 BJD.docx; B2 BJD.docx; B5 (eh 091418) BJD.docx; B1 BJD.docx

Here are my contributions so far. The more I worked on these the more I focused on the main text and not the underlying comments and rationale. I'd caution against having too much supplemental info beyond the main text if you want these to be useful while you're in plenary.

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> Alice
>
> **Official**
>
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> **To:** Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Fawcett, Allen' <Fawcett.Allen@epa.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
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> **Subject:** RE: IPCC 48 preparations
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D1: Allen

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D4: Eric and Allen

D5: Farhan and Eric

D6: Farhan and Eric

--

Benjamin DeAngelo
Deputy Director
NOAA Climate Program Office
cpo.noaa.gov

301-734-1093 office
240-750-8243 cell
ben.deangelo@noaa.gov

Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/17/2018 11:20:45 PM
To: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: Re: IPCC 48 preparations - C2, C3, D4
Attachments: D4 (eh 091718).docx; C2 (eh 091718 second pass).docx

Hi Allen,

Sending you a revised D4 as well as some additional comments/edits on C2. I will try to look at C3 some more tomorrow or Weds.

Best,
Eric

Eric Haxthausen
Senior Advisor
Global Climate Change Office
Bureau for Economic Growth, Education, and Environment
USAID

ehaxthausen@usaid.gov
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+1 (202) 550-3343 (mobile)

On Thu, Sep 13, 2018 at 2:04 PM Eric Haxthausen <ehaxthausen@usaid.gov> wrote:

> Allen,
>
> good to catch up. For your reference, here are latest copies of my noodling on the sections we discussed. Yellow highlights generally mean that it merits looking into further. Green highlights in the comments section mean that I agree with the comment but haven't implemented a suggest text revision. We didn't really discuss the toplines, but for some of the documents, I've started pulling them into the subsection page and revising them; you can see that in the updated version of A5.
>
> I'll work on D4 some more, and will look for some time on Monday for another call.
>
> best,
> Eric
>
> Eric Haxthausen
> Senior Advisor
> Global Climate Change Office
> Bureau for Economic Growth, Education, and Environment
> USAID
>
> ehaxthausen@usaid.gov
> +1 (202) 216-3263 (office)

+1 (202) 550-3343 (mobile)

On Wed, Sep 12, 2018 at 5:00 PM Fawcett, Allen <Fawcett.Allen@epa.gov> wrote:

Sounds great Eric. Go ahead and give me a call tomorrow around then.

Allen

Allen A. Fawcett, Ph.D.

Chief, Climate Economics Branch

U.S. Environmental Protection Agency

Office: (202) 343-9436

Cell: (202) 412-5116

From: Eric Haxthausen [mailto:ehaxthausen@usaid.gov]
Sent: Wednesday, September 12, 2018 4:50 PM
To: Fawcett, Allen <Fawcett.Allen@epa.gov>
Subject: Re: IPCC 48 preparations - C2, C3, D4

Hi Allen,

I could talk for a bit tomorrow at around 1:30 or a little before that. I haven't started looking at those sections yet, but will try to skim through them tomorrow. (I have been reviewing some of the items in A, B, and D, which arguably overlap with C.)

Shall I call you tomorrow around that time?

best,

Eric

Eric Haxthausen

Senior Advisor

Global Climate Change Office

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On Wed, Sep 12, 2018 at 4:18 PM Fawcett, Allen <Fawcett.Allen@epa.gov> wrote:

> Hi Eric,
>
> I've started on C2 since that subsection is most relevant to our topline comments. I haven't done much on C3 yet, but it does have a fair number of more detailed comments. D4 looks pretty light on comments, not sure how much there is to do there. Would you have time for a call tomorrow to discuss? I'm free 11:30-2 if there's a time in there that works for you.
>
> Allen
>
> ---
>
> Allen A. Fawcett, Ph.D.
>
> Chief, Climate Economics Branch
>
> U.S. Environmental Protection Agency

Office: (202) 343-9436

Cell: (202) 412-5116

From: Eric Haxthausen [mailto:ehaxthausen@usaid.gov]
Sent: Tuesday, September 11, 2018 6:05 PM
To: Fawcett, Allen <Fawcett.Allen@epa.gov>
Subject: Re: IPCC 48 preparations - C2, C3, D4

Hi Allen,

Curious whether you have started on the above subsections (C2, C3, D4) on which Alice asked us to collaborate.

best,

Eric

Eric Haxthausen

Senior Advisor

Global Climate Change Office

Bureau for Economic Growth, Education, and Environment

USAID

ehaxthausen@usaid.gov

+1 (202) 216-3263 (office)

+1 (202) 550-3343 (mobile)

On Fri, Aug 31, 2018 at 4:31 AM Alpert, Alice <AlpertA@state.gov> wrote:

Hello expert team,

We are starting to prepare our arguments and preferred SPM text for the October meeting. I've outlined a process below for preparing our paper for the meeting, noting that another draft of the SPM will be released immediately ahead of the meeting, or possibly on its first day. Some of our comments on the existing version may be addressed in that draft, and there may also be additions from other countries. So, we will need be prepared to respond in either case.

I have prepared several documents to aid in this preparation:

- a document ("US Toplines") with a topline argument for each SPM heading
- A spreadsheet with the whole SPM comments we submitted that could be useful for arguments on individual SPM statements.
- I have also prepared a word document for each SPM heading, and populated them with the relevant comments we transmitted in July in the heading and its sub-bullets.

Since some of our transmitted comments are mutually inconsistent we will need to develop an official view/objective for each statement and section.

What we are asking you to do is:

- For each SPM heading and sub-heading (e.g., A1 and A1.1, A1.2, and A1.3) relevant to your review, identify if and how you would like the SPM text to be changed. It would be good to also identify one or two acceptable fallback options based on the underlying chapter. Please add the alternate text and references to the underlying chapter, as appropriate, to the specific heading document.
- Edit the comments and topline priority for the statements in the "US Approach" document in track changes, adding talking points to argue for these changes. You may want to remove some comments and focus on a subset that you can further support using the underlying chapter text.

Many of the statements are relevant for more than one reviewer, and I encourage you to coordinate with each other as you prepare. See the list below for suggestions.

We plan to schedule a call to check in and answer questions later this week or next week. Trigg, Farhan, and I will be at a meeting in Bangkok, 11 hours ahead of EDT until September 12th. We'll look to have comments and positions by Sept 19 for final consolidation.

Definitions: all, as relevant

Introduction: Steve

A1: Steve with Ch3

A2: Steve with Allen

A3: Ben with Eric

A4: Eric and Farhan

A5: Eric and Farhan with Allen

Figure 1: Allen and Steve

B1: Ben

B2: Ben

B3: Ben

B4: Ben

B5: Ben, Eric, Farhan

B6: Eric and Farhan

Figure 2: Ben, Eric, Farhan

C1: Allen (with Farhan on C1.2)

C2: Allen and Eric

C3: Allen and Eric

Figure 3: Allen

Figure 4: Farhan

D1: Allen

D2: Farhan and Eric

D3: Farhan and Eric

D4: Eric and Allen

D5: Farhan and Eric

D6: Farhan and Eric

Official

UNCLASSIFIED

Message

From: Stenhouse, Jeb [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=E8521E7F3AAC43ADBB52FAC73CFB22DA-STENHOUSE, JEB]
Sent: 11/13/2018 9:03:43 PM
To: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: IPCC moment

Chatham House Rules so I can' t say who and what organization, but a participant at this EPRI workshop noted that citizens showed up to her company' s stakeholder process recently with the newest IPCC report in hand and demanded to know what the utility was going to do about it.

Message

From: Alpert, Alice [AlpertA@state.gov]
Sent: 9/27/2018 10:01:48 PM
To: Stephen Gray [sgray@usgs.gov]
CC: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Akhtar, Farhan H [AkhtarFH@state.gov]
Subject: RE: [EXTERNAL] drilling down on rates of warming and cumulative warming

Sounds good, Steve.

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From: Stephen Gray <sgray@usgs.gov>
Sent: Thursday, September 27, 2018 4:56 PM
To: Alpert, Alice <AlpertA@state.gov>
Cc: Fawcett.Allen@epa.gov; Akhtar, Farhan H <AkhtarFH@state.gov>
Subject: Re: [EXTERNAL] drilling down on rates of warming and cumulative warming

Hi Alice-

What we do by referring to as "early as the 2030s" and likely "no later than the 2060s", is capture the entire 95% confidence interval as it ties back to the uncertainty in the warming rate (+/- .1 C per decade). I also used 2030's, etc instead of single years given that the rate is based on decadal averages. If all that makes sense, I'll take another crack at editing.

Steve

Sent from my iPhone

On Sep 27, 2018, at 12:59 PM, Alpert, Alice <AlpertA@state.gov> wrote:

> Hello Steve,
>
> I like the way your first option spells out the temporal uncertainty. The probability and confidence statements are the key, and our fix should be particularly clear on that point. So could you elaborate on or change your proposed text below? (notes in red are mine)
>
> If emissions continue (increasing?) at their present rate, human-induced warming ~~e~~would (request authors to assign a probability) exceed 1.5°C as early as ~~the~~ 2030~~'s~~, and very likely (is this referring to a 2/3 chance stated somewhere in the underlying chapter?) no later than ~~the~~ 2060~~'s~~..."
>
> The second option could work too:
> "A2. If emissions continue (increasing?) at their present rate, human-induced warming would (request authors to assign a probability) ~~will exceed~~ reach 1.5°+/-0.3 C by ~~the~~ 2040~~'s~~...".
>
> **Official - SBU**
> UNCLASSIFIED

From: Stephen Gray <sgray@usgs.gov>
Sent: Thursday, September 27, 2018 10:40 AM
To: Alpert, Alice <AlpertA@state.gov>
Cc: Akhtar, Farhan H <AkhtarFH@state.gov>; Fawcett.Allen@epa.gov
Subject: Re: [EXTERNAL] drilling down on rates of warming and cumulative warming

So, I think the best way to handle A2.1 is to follow a couple of previous suggestions and break out subsequent periods of warming/not warming:

"If all anthropogenic emissions (including greenhouse gases, aerosols and their precursors) were reduced to zero immediately, it is very likely that warming would continue for another decade. Further warming over the next two to three decades would likely be less than 0.5°C (high confidence), and likely less than 0.5°C by end of the century (medium confidence), due to the compensating effects of multiple climate processes and climate forcers. {1.2.4, Figure 1.6}."

If that treatment looks reasonable, I can also clean up the other "A" messages we've edited to match.

Steve

Sent from my iPhone

On Sep 25, 2018, at 3:15 PM, Alpert, Alice <AlpertA@state.gov> wrote:

> Hello Steve,
>
> I am sorry that you ran into a travel snag and hope that it wasn't too inconvenient a problem to solve.
>
> We have identified accurate representation of warming rates and projections of warming as a US priority at the IPCC meeting next week. Several USG comments on sections A1 and A2 pointed this out, and it would be very helpful to dig a bit deeper in preparing our ideal text and supporting arguments. Please update the A1 and A2 papers to ensure that the following statements regarding projected warming rates and cumulative warming are mutually consistent:
> In a no further emissions scenario:
>
> **A1.2.** Energy continues to accumulate in the climate system due to past and present greenhouse gas emissions and other anthropogenic climate forcers (*very high confidence*), causing continued warming at a rate of 0.2°C/decade with a *likely* range of ±0.1oC (*high confidence*).
>
> **A2.1.** If all anthropogenic emissions (including greenhouse gases, aerosols and their precursors) were reduced to zero immediately, it is *likely* that any further warming would be less than 0.5°C over the next two to three decades (*high confidence*), and *likely* less than 0.5°C on a century time scale (*medium confidence*), due to the compensating effects of different climate processes and climate forcers.{1.2.4, Figure 1.6}
>
> In particular the highlighted confidence statement is inconsistent with the uncertainty range on the decadal warming rate.

II. In a continuing emissions scenario:

> **A2.2.** If emissions continue at their present rate over the coming decades, the present rate of human-induced warming of 0.2±0.1ₒC per decade will continue (*very high confidence*). {1.2.1, 1.2.4}
>
> **A2. Past emissions alone are *unlikely* to raise GMST to 1.5°C above pre-industrial levels, but do commit to further changes such as sea-level rise and associated impacts (*high confidence*). If emissions continue at their present rate, human-induced warming will exceed 1.5°C by around 2040 (*high confidence*). {1.2, 3.3, Figure SPM 1}**

In particular the word "will" and the highlighted confidence statement seem inconsistent with the uncertainty range on the decadal warming rate.

Please let me or Farhan know if you have any questions, and circulate to the broader expert group for comment as soon as you're ready. Thank you so much.

Alice

Official
UNCLASSIFIED

<A1 stg wrk i.docx>

<A2 (aaf 091918) (STG wrk ii).docx>

Message

From: Stephen Gray [sgray@usgs.gov]
Sent: 9/27/2018 2:40:14 PM
To: Alpert, Alice [AlpertA@state.gov]
CC: Akhtar, Farhan H [AkhtarFH@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: Re: [EXTERNAL] drilling down on rates of warming and cumulative warming

So, I think the best way to handle A2.1 is to follow a couple of previous suggestions and break out subsequent periods of warming/not warming:

"If all anthropogenic emissions (including greenhouse gases, aerosols and their precursors) were reduced to zero immediately, it is very likely that warming would continue for another decade. Further warming over the next two to three decades would likely be less than 0.5°C (high confidence), and likely less than 0.5°C by end of the century (medium confidence), due to the compensating effects of multiple climate processes and climate forcers. {1.2.4, Figure 1.6}."

If that treatment looks reasonable, I can also clean up the other "A" messages we've edited to match.

Steve

Sent from my iPhone

On Sep 25, 2018, at 3:15 PM, Alpert, Alice <AlpertA@state.gov> wrote:

> Hello Steve,
>
> I am sorry that you ran into a travel snag and hope that it wasn't too inconvenient a problem to solve.
>
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> In a no further emissions scenario:
>
> **A1.2.** Energy continues to accumulate in the climate system due to past and present greenhouse gas emissions and other anthropogenic climate forcers (*very high confidence*), causing continued warming at a rate of 0.2°C/decade with a *likely* range of ±0.1oC (*high confidence*).
>
> **A2.1.** If all anthropogenic emissions (including greenhouse gases, aerosols and their precursors) were reduced to zero immediately, it is *likely* that any further warming would be less than 0.5°C over the next two to three decades (*high confidence*), and *likely* less than 0.5°C on a century time scale (*medium confidence*), due to the compensating effects of different climate processes and climate forcers.{1.2.4, Figure 1.6}
>
> In particular the highlighted confidence statement is inconsistent with the uncertainty range on the decadal warming rate.
>
> II. In a continuing emissions scenario:

A2.2. If emissions continue at their present rate over the coming decades, the present rate of human-induced warming of 0.2±0.1ₒC per decade will continue (*very high confidence*). {1.2.1, 1.2.4}

A2. Past emissions alone are *unlikely* to raise GMST to 1.5°C above pre-industrial levels, but do commit to further changes such as sea-level rise and associated impacts (*high confidence*). If emissions continue at their present rate, human-induced warming will exceed 1.5°C by around 2040 (*high confidence*). {1.2, 3.3, Figure SPM 1}

In particular the word "will" and the highlighted confidence statement seem inconsistent with the uncertainty range on the decadal warming rate.

Please let me or Farhan know if you have any questions, and circulate to the broader expert group for comment as soon as you're ready. Thank you so much.

Alice

Official
UNCLASSIFIED

<A1 stg wrk i.docx>

<A2 (aaf 091918) (STG wrk ii).docx>

Message

From: Stephen Gray [sgray@usgs.gov]
Sent: 9/27/2018 3:05:15 AM
To: Alpert, Alice [AlpertA@state.gov]
CC: Akhtar, Farhan H [AkhtarFH@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: Re: [EXTERNAL] drilling down on rates of warming and cumulative warming

Alice and Co (adding Allen back in)-

I think A1 (plus a minor tweak) can stand more-or-less as is. Will get that to you tomorrow.

For A2., recall that we suggested splitting the message into a top bullet that addresses what happens if emissions continue at their present rate, and a secondary bullet that deals with the commitment to warming based on emissions to date. With that said, we might better represent a warming rate of 0.2 +/-0.1 C by going with something along the lines of:

"A2. If emissions continue at their present rate, human-induced warming could exceed 1.5°C as early as the 2030's, and very likely no later than the 2060's..."

We could also say, "A2. If emissions continue at their present rate, human-induced warming will exceed 1.5°+/-0.3 C by the 2040's..." but I'm not sure that's much better than the original.

I'm still working on A2.1. After reading it a few more times, A2.1 almost seems redundant. But, I'll see if it can be redeemed before suggesting that we just throw it out or absorb it into other key messages.

Am I on the right track here? Thoughts?

Thanks,
Steve

Sent from my iPhone

On Sep 25, 2018, at 3:15 PM, Alpert, Alice <AlpertA@state.gov> wrote:

> Hello Steve,
>
> I am sorry that you ran into a travel snag and hope that it wasn't too inconvenient a problem to solve.
>
> We have identified accurate representation of warming rates and projections of warming as a US priority at the IPCC meeting next week. Several USG comments on sections A1 and A2 pointed this out, and it would be very helpful to dig a bit deeper in preparing our ideal text and supporting arguments. Please update the A1 and A2 papers to ensure that the following statements regarding projected warming rates and cumulative warming are mutually consistent:
> In a no further emissions scenario:
>
> **A1.2.** Energy continues to accumulate in the climate system due to past and present greenhouse gas
> emissions and other anthropogenic climate forcers (*very high confidence*), causing continued warming
> at a rate of 0.2°C/decade with a *likely* range of ±0.1°C (*high confidence*).

A2.1. If all anthropogenic emissions (including greenhouse gases, aerosols and their precursors) were reduced to zero immediately, it is *likely* that any further warming would be less than 0.5°C over the next two to three decades (*high confidence*), and *likely* less than 0.5°C on a century time scale (*medium confidence*), due to the compensating effects of different climate processes and climate forcers.{1.2.4, Figure 1.6}

In particular the highlighted confidence statement is inconsistent with the uncertainty range on the decadal warming rate.

II. In a continuing emissions scenario:

A2.2. If emissions continue at their present rate over the coming decades, the present rate of human-induced warming of 0.2±0.1oC per decade will continue (*very high confidence*). {1.2.1, 1.2.4}

A2. Past emissions alone are *unlikely* to raise GMST to 1.5°C above pre-industrial levels, but do commit to further changes such as sea-level rise and associated impacts (*high confidence*). If emissions continue at their present rate, human-induced warming will exceed 1.5°C by around 2040 (*high confidence*). {1.2, 3.3, Figure SPM 1}

In particular the word "will" and the highlighted confidence statement seem inconsistent with the uncertainty range on the decadal warming rate.

Please let me or Farhan know if you have any questions, and circulate to the broader expert group for comment as soon as you're ready. Thank you so much.

Alice

Official
UNCLASSIFIED

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<A2 (aaf 091918) (STG wrk ii).docx>

- A core weakness of the report is that the **economic costs of mitigation**, which is of major interest to policy makers, are not addressed in a clear and consistent way. For example, the underlying report does not address the total costs of mitigation in any clear way, despite the existence of literature addressing this subject. Hence the report fails to provide a basis for comparing the benefits and costs of holding temperature to 1.5°C. to other potential policy targets.
- Another concern is that the relevant topic of the intersections of mitigation and adaptation strategies with sustainable development is treated in a way that does not reflect the scientific standard of the IPCC. First, the report assigns too great a weight – essentially an entire chapter – to a topic that is of larger policy relevance but generally beyond the IPCC's remit. Second, by emphasizing the topline titles of individual SDGs, the report takes a broad-brush approach that blurs important distinctions among individual targets under each SDG and regarding impacts within specific sectors. Third, in discussing individual SDGs, the report in some cases relies on narrow or idiosyncratic strands of the literature to make sweeping claims about synergies or tradeoffs.
    - As just one salient illustration, the discussion of how replacing coal with biomass could affect SDG 2 ("End hunger, achieve food security and improved nutrition and promote sustainable agriculture") considers only one of the five targets under SDG 2 (2.3 – farm incomes) and gives little or no weight to the impact of increased bioenergy production on available land for, and prices of, food crops. Moreover, many of the sources for this discussion are not found in the reference list.
- We are also concerned that the report in many places fails to make sufficient distinctions between general claims and claims that are **specific to** the challenges associated with warming of **1.5 degrees C**. This reduces its utility to policy makers.
- In some cases, when treating less technical topics, for example in the later parts of Chapter 4, the report makes unbalanced or tendentious statements that veer into philosophical or policy judgements. In contrast, there are important technical topics, such as disaster risk management, that receive insufficient attention given their relevance to this topic.
- More generally, the significant rewrites between the second-order draft and the final government draft have meant that we and other governments have not been able to provide the detailed review of some of the underlying material that would be warranted.

Message

From: David Dokken (Contractor) [ddokken@usgcrp.gov]
Sent: 9/25/2018 1:59:01 PM
To: Eric Haxthausen [ehaxthausen@usaid.gov]; Talley, Trigg [talleyt@state.gov]; ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]; sgray@usgs.gov
CC: Seen, Emily J [SeenEJ@state.gov]
Subject: Re: Fwd: IPCC 1.5 SPM commentary
Attachments: SR15_FOD_SPM.pdf

Hi Eric -

The Government Review draft did mention conflict and displacement of people (see Section 2.7 in the attached).

Even so, the Guardian piece is too harsh on the authors, disregarding process of SPM development vs. that of the underlying report. Usually the TechSum would fill void but SR1 doesn't have one.

Pending report release 8 October already getting coverage, in this case for CDR: https://www.axios.com/earths-climate-change-liposuction-sucking-carbon-from-the-air-471783e6-3865-4904-8c06-759a7ad31511.html

Starting to think about populating the SR2 and SR3 expert panels. Any of you willing to re-up. I can provide more information.

dave

On 9/24/18 9:43 AM, Eric Haxthausen wrote:

> Flagging for your awareness a Guardian piece yesterday on the report alleging that the SPM has been "watered down". I don't recall actually seeing these points - perhaps they were in the SPM first draft?
>
> https://www.theguardian.com/science/2018/sep/23/scientists-changing-global-warming-report-please-polluters

---------- Forwarded message ---------
From: **Noel Gurwick** <ngurwick@usaid.gov>
Date: Mon, Sep 24, 2018 at 9:26 AM
Subject: IPCC 1.5 SPM commentary
To: Eric Haxthausen <ehaxthausen@usaid.gov>, Collin Green <cgreen@usaid.gov>, Geoffrey Blate <gblate@usaid.gov>, Juliann Aukema <jaukema@usaid.gov>, Katherine Faulhaber <kfaulhaber@usaid.gov>, Kathryn Stratos <kstratos@usaid.gov>, Lexine Hansen <lhansen@usaid.gov>, Matthew Ogonowski <mogonowski@usaid.gov>, ngurwick@usaid.gov <ngurwick@usaid.gov>, Peter Epanchin <pepanchin@usaid.gov>

Climate study 'pulls punches' to keep polluters on board

The Observer reports on accusations that key messages from the upcoming Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5C have been "watered down" to make them more "palatable" to countries that are reluctant to cut their fossil fuel emissions. Bob Ward, policy director at the Grantham Research Institute on Climate Change and the Environment, is a reviewer of the report who has seen several drafts of the report and its accompanying summary for policymakers. He told the Observer: "Downplaying the worst impacts of climate change has led the scientific authors to omit crucial information from the summary for policymakers." According to Ward, edits have been made to the summary for policymakers – the document that will act as a guideline for politicians – to omit "any mention that temperature rises of above 1.5C could lead to increased migrations and conflict". Other edits include the removal of "warnings about the dangers that 1.5-2C temperature rises could trigger irreversible loss of the Greenland ice sheet and raise sea levels by 1-2 metres over the next two centuries," the Observer reports. An IPCC spokesperson told the Observer that member governments would work to ensure the summary for policymakers was consistent with the findings in the main report. "Any text in the summary for policymakers ... is based on the assessment in the main report. Even if it is removed from the summary for policymakers, the finding it is based on remains in the main report." On Twitter, report author Prof Piers Forster said he "completely disagreed" with the accusations. Robin McKie, The Observer

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Noel Gurwick, Ph.D.
USAID Global Climate Change Office
E3/GCC Room 3.08.121B
1300 Pennsylvania Ave NW, Washington DC
Tel: 202-712-0574
Email: ngurwick@usaid.gov
www.usaid.gov/climate

--
David Dokken | Senior Program Officer | o: 202.419.3473 | ddokken@usgcrp.gov | www.globalchange.gov
U.S. Global Change Research Program (Contractor) | 1800 G Street, NW, Suite 9100, Washington, DC 20006

Summary for Policy Makers

Drafting Authors:
Myles Allen (UK), Heleen De Coninck (The Netherlands), Opha Pauline Dube (Botswana), Marion Ferrat (UK/France), Ove Hoegh-Guldberg (Australia), Daniela Jacob (Germany), Kejun Jiang (China), Valérie Masson-Delmotte (France), Wilfran Moufouma-Okia (France/Congo), Rosalind Pidcock (UK), Anna Pirani (Italy), Elvira Poloczanska (Germany), Hans-Otto Pörtner (Germany), Aromar Revi (India), Debra C. Roberts (South Africa), Joeri Rogelj (Austria/Belgium), Joyashree Roy (India), Priyadarshi R. Shukla (India), James Skea (UK), Raphael Slade (UK), Drew Shindell (USA), William Solecki (USA), Michael Taylor (Jamaica), Petra Tschakert (Australia), Henri Waisman (France), Panmao Zhai (China)

Date of Draft: 08 January 2018

Notes: First Order Draft of SR1.5 SPM for Expert and Government review.

SPM 1 Introduction

SPM 1.1 Context

This summary presents key findings from the Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. The narrative of the summary is supported with a series of highlighted headline statements.

The certainty in key assessment findings[1] in this Special Report is communicated as in the IPCC AR5[2] Working Group Reports and Special Reports. The constraints on the timeline and literature available for the preparation of this report means that many policy-relevant statements are presented with a confidence qualifier, not a likelihood and this does not detract from their importance. {1.6}

The Special Report is prepared in the context of unequivocal and sustained global warming and sea level rise, and continued emissions of greenhouse gases. The Special Report assesses knowledge on global climate change, regional climate changes, vulnerabilities, impacts and risks at 1.5°C global warming above pre-industrial levels for natural and human systems, taking into account adaptive capacities and their limits. It provides new insights on impacts that may be avoided with 1.5°C global warming compared to 2°C. It explores global greenhouse gas emission pathways consistent with limiting global warming to 1.5°C above pre-industrial levels, including those which temporarily exceed 1.5°C global warming before returning to 1.5°C by the end of this century. The Special Report assesses the pace and scale of transformations consistent with limiting global warming to 1.5°C compared to 2°C global warming, in the context of sustainable development, poverty eradication and equity, considering adaptation and mitigation options.

This report includes information relevant to the Paris Agreement including: Article 2 on strengthening the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty; Article 4 on achieving a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity; Article 7 on enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development; Article 8 on averting, minimizing and addressing loss and damage associated with the adverse effects of climate change; Article 9 on providing financial resources to assist developing country Parties; Article 10 on sharing a long-term vision on the importance of fully realizing technology development and transfer; Article 11 on enhancing the capacity and ability of developing country Parties, in particular countries with the least capacity; Article 12 on enhancing climate change education, training, public awareness, public participation and public access to information; and Article 14 on the Global Stocktake.

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[1] Each finding is grounded in an evaluation of underlying evidence and agreement. In many cases, a synthesis of evidence and agreement supports an assignment of confidence. The summary terms for evidence are: limited, medium or robust. For agreement, they are low, medium or high. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, e.g., *medium confidence*. The following terms have been used to indicate the assessed likelihood of an outcome or a result: virtually certain 99–100% probability, very likely 90–100%, likely 66–100%, about as likely as not 33–66%, unlikely 0–33%, very unlikely 0–10%, exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%, more likely than not >50–100%, more unlikely than likely 0–<50%, extremely unlikely 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, e.g., *very likely*. See for more details: Mastrandrea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.-K. Plattner, G.W. Yohe and F.W. Zwiers, 2010: Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties, Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, 4 pp

[2] AR5: Fifth Assessment Report of the IPCC.

Box SPM 1: Definition of global mean surface temperature change and 1.5°C global warming

This report adopts a working definition of global mean surface temperature change at any given time relative to the climatology of pre-industrial levels as combined land surface air temperature and sea surface temperature, averaged for a 30-year period centred on that time. The climatology of pre-industrial global mean is based on the 51-year period 1850-1900. (Figure SPM1) {1.2, Figure 1.2}

In this report, '1.5°C global mean temperature' or '1.5°C warmer world' refers to a 1.5°C human-induced globally-averaged surface temperature change above the pre-industrial climatology.

SPM 1.2 High level statements from this report

- There is very high risk that under current emission trajectories and current national pledges global warming will exceed 1.5°C above preindustrial levels. Limiting global warming to 1.5°C would require a rapid phase out of net global carbon dioxide (CO_2) emissions and deep reductions in non-CO_2 drivers of climate change such as methane, with more pronounced and rapid reductions required than for limiting global warming to 2°C.

- Even if global warming is limited to 1.5°C above pre-industrial temperatures, climatic trends and changing extreme events in oceans and over land imply risks for ecosystems and human societies larger than today, especially where vulnerabilities are highest. Projected impacts are larger at 2°C, with the potential to affect more strongly economic development, increase costs of adaptation, damage, and loss, and cause increasing risks by exceeding the adaptive capacity of vulnerable systems. Sea level rise will continue for centuries at both 1.5°C and 2°C global warming.

- In a 1.5°C warmer world, climate change and climate change responses will affect people in countries at all levels of development, but those most at risk will be individuals and communities experiencing multidimensional poverty, persistent vulnerabilities, and various forms of deprivation and disadvantage. This is unless adaptation and mitigation actions are guided by concerns for equity and fairness and enhanced support for eradicating poverty and reducing inequalities.

- Holding global warming to below 1.5°C implies transformational adaptation and mitigation, behaviour change, supportive institutional arrangements and multi-level governance.

- Emissions reductions in all sectors would be needed in order to meet the long-term temperature goal of the Paris Agreement. All available 1.5°C pathways include three broad approaches, to varying extent. The first is lowering energy demand in buildings, industry and transport, and demand for agricultural products. The second is lowering emissions from energy supply, land use and agriculture through, for example, the deployment of low carbon energy technologies. The third is through removing carbon dioxide from the atmosphere.

- Different portfolios of emission reduction measures have different implications for sustainable development, including regional climate change, food security, biodiversity, the provision of ecosystem services, and the vulnerability of the poor. While demand side measures have many synergies with sustainable development, portfolios that mainly consider supply side measures and affect patterns of land use carry a greater risk of trade-offs.

- Delayed action or weak near-term policies increase mitigation challenges in the long-term and increase the risks associated with exceeding 1.5°C global warming temporarily (referred to as 'overshoot') or of warming remaining above 1.5°C by the end of the century. Delayed action or weak near-term policies increase the severity of projected impacts and adaptation needs. Modelling suggests that having a 66% likelihood of holding warming below 1.5°C throughout the 21st century without overshoot is already out of reach.

SPM 1.3 Background

1.1 Greenhouse gas emissions from human activities are the dominant cause of global warming, which has been occurring at an average rate of 0.17°C (±0.07°C) per decade since 1950. The global mean temperature in 2017/18 is estimated to be 1°C higher relative to pre-industrial levels. At current rates of warming, global mean temperature would reach 1.5°C by the 2040s. {1.1, 1.2.2, 1.2.3}

- The global mean temperature reached approximately 1°C above pre-industrial levels around 2017/2018[3]. Over one quarter of the global population lives in regions that already experience greater warming than the global average, with annual mean temperatures exceeding 1.5°C in at least one season. Such regions are found particularly in northern mid- and high-latitudes *(high confidence)*. (Figure SPM1) {1.1, 1.2.2, 1.2.3, Figure 1.3}

- At the present rate of greenhouse gas emissions and global warming of 0.17°C (±0.07°C) per decade, as assessed in the AR5, global mean temperatures would reach 1.5°C in the 2040s *(high confidence)*. (Figure SPM1) {1.2.2, 1.2.3}

1.2 Future global warming will depend primarily on future cumulative CO_2 emissions. As cumulative CO_2 emissions are reduced under ambitious mitigation scenarios, the mitigation of emissions of other climate warming agents becomes progressively more important. {1.2.6, 2.2, 2.3}

- Avoiding substantial global mean warming (more than 0.2°C) beyond what is already experienced is geophysically possible, but depends on rates of reductions in emissions of climate forcers. There would be a regional adjustment following a cessation of emissions, such that some regions would warm even if the global mean temperature does not *(high confidence)*. (Figure SPM1) {1.2.6, 2.2, 2.3}

- Limiting global mean warming to 1.5°C would require rapid and deep reductions in greenhouse gas emissions, even with a temporary overshoot and later return to 1.5°C warming. The Nationally Determined Contributions (NDCs) submitted under the Paris Agreement will result, in aggregate, in global greenhouse gas emissions in 2030 that are higher than those in scenarios compatible with limiting global warming to 1.5°C by 2100. {1.2.2, 2.3.1, 2.3.4, 2.2.5, 4.3.8; Cross-Chapter Box 4.1}

[3] This is using the definition of SPM Box 1 and includes an extrapolation or near term predictions of future warming so that the level of anthropogenic warming is reported for a 30 year period centered on today.

1.3 At 1.5°C global warming, the risks to natural, managed and human systems depend on development pathways, levels of vulnerability, on the choices of adaptation and mitigation options, on the occurrence of overshoot above 1.5°C, and their different implications at regional scales. Adaptation and mitigation measures also have consequences for sustainable development. {1.3, Cross-Chapter Box 3.2, 5.6}

- Impacts at 1.5°C in this report refers to the projected impacts when global mean temperature is 1.5°C above pre-industrial levels. {1.3}

- Many impacts are different in a world where global warming is limited to 1.5°C compared to a world in which global mean temperature temporarily overshoots 1.5°C. As some impacts are irreversible, such as mortality of species and ecosystems, even brief periods of overshoot can have long-lasting impacts on natural systems, especially if the peak in global mean temperature is high *(high confidence)*. {Cross-Chapter Box 3.2}

- Impacts will depend on the level of vulnerability of human and natural systems, their capacity to adapt to changing conditions, and the stage of differential national development trajectories. (Figure SPM3) {5.6}

- Climate-resilient development pathways have the potential to meet the goals of sustainable development, including poverty eradication and reducing inequalities, while emphasising equity and fairness with respect to the deep societal transformation needed to limit global warming to 1.5°C and to achieve desirable futures and well-being for all. {5.6, Figure 5.5}

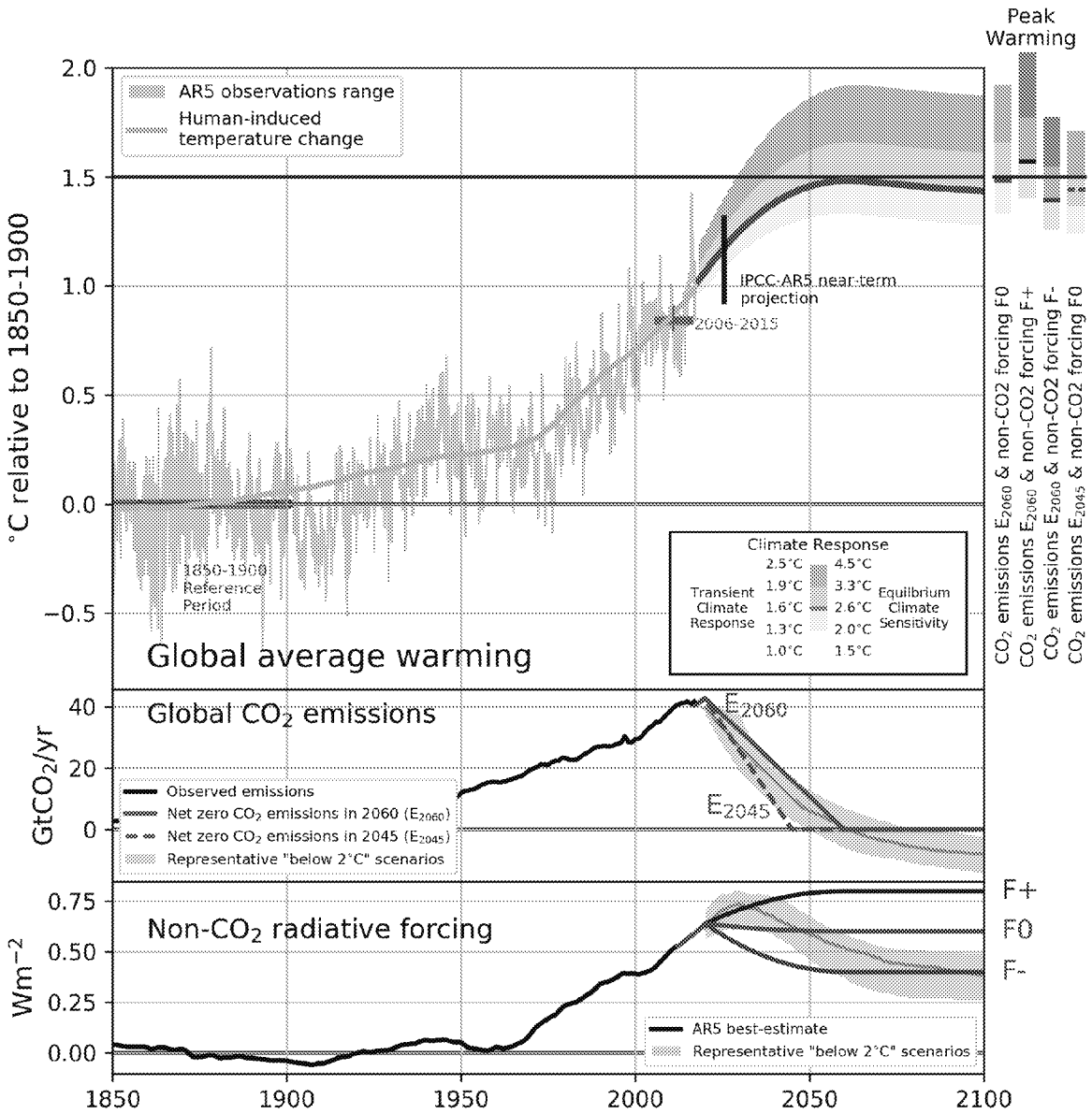


Figure SPM 1: Observed global warming, and estimation of human-induced temperature change for a range of possible climate response magnitudes. Illustration of future warming response to two stylized scenarios of reductions in CO2 emissions, with different hypothetical non-CO2 forcing stabilization.

Change in global mean temperature using updated AR5 observational datasets (grey shaded band) updated until end of 2016, relative to the reference period 1850-1900. The average warming levels corresponding to the SR1.5 near-term reference period (2006-2015) is shown with uncertainties (vertical green bar). One estimate of historical human-induced temperature change is shown {Figure 1.1}, with the yellow vertical bar indicating the estimated uncertainties in the human-induced warming for the final data point (2016) calculated using the relative uncertainty in near-term warming trend from AR5. The AR5 assessment of near-term projections are marked with a black bar. Possible global temperature responses to a stylized linear decline of CO_2 emissions from 2020 to net zero in 2060 (E_{2060}, middle panel) is shown (upper panel, green shading) for a set of possible climate system properties taken from across the AR5 assessed ranges, and assuming a

future non-CO_2 radiative forcing that stabilises at present-day levels (F0 – bottom panel). Bars to the right of the upper panel illustrate the possible peak warming under different stabilised levels of future non-CO_2 radiative forcing levels above or below current levels (blue and brown bars), and under a more rapid stylized decline in CO_2 emissions to reach net-zero in 2040 (E_{2045}, right-most bar). The 17-83 percentiles of the scenarios ensemble described in {Chapter 2} are shown in the bottom two panels for reference.

SPM 2 Impacts of 1.5°C global warming and associated risks

[Missing confidence statements to be complemented after revision of Chapter 3 Executive Summary]

2.1 Every increase of 0.5°C of global mean surface temperature increases the risks of climate change impacts. The increase in global land surface temperatures is larger than the global average. Risks associated with changes in precipitation patterns and some extreme events, storms, and sea level rise increase *(high confidence)*. The rise in extreme temperatures in some regions can be more than three times larger than the change in global mean surface temperature. {3.3.1, 3.3.2, 3.3.7, Cross-Chapter Box 3.2, Cross-Chapter Box 4.3}

- Changes in temperature and preciptation extreme indices are detectable in observations for the 1991-2010 period compared with 1960-1979, during which time an approximate 0.5°C global warming occurred. {3.3.1}

- In some regions, the rise in extreme temperatures is projected to be more than three times larger than the change in global mean surface temperature. {3.3.1, 3.3.2, Cross-Chapter Box 3.2}

- The risks from land-based heatwaves and temperature extremes increase with global mean temperature rise. There is a faster rate of increase of temperature extremes in most land regions at 2°C compared to 1.5°C, in particular in Central and Eastern North America, Central and Southern Europe, the Mediterranean, Western and Central Asia, and Southern Africa. {3.3.1, 3.3.2, Cross-Chapter Box 3.2}

- An increased risk from hot days (10% of warmest days) occurs with the additional 0.5°C from 1.5°C to 2°C global warming. The increase in risk is most pronounced in the tropics. (Figure SPM3) {3.3.1, 3.3.2, Cross-Chapter Box 3.2}

- Projected risks from water scarcity, flood and drought are greater at 2°C global warming compared to 1.5°C. The largest increase of risks associated with floods at 2°C, compared to 1.5°C, are projected in Asia, North America and Europe. The greatest increase in water stress is projected for the Mediterranean region. (Figure SPM3) {Cross-Chapter Box 4.3}

- There is greater risk from the most intense tropical cyclones with 2°C of global warming compared to 1.5°C. The most intense (category 4 and 5) tropical cyclones are projected to occur more frequently, with higher peak wind speeds and lower central pressures at 2°C compared to 1.5°C of global warming. {3.3.7}

2.2 Climate change impacts all ecosystems and their services on all continents and in the oceans, including terrestrial, wetland and freshwater, marine and coastal ecosystems. Risks increase between today and global warming of 1.5°C, as well as between 1.5°C and 2°C global warming. {3.3.1, 3.3.2, 3.3.3., 3.3.4, 3.4.9, 3.5.6, Box 3.5}

- Impacts on natural systems are *likely* to be less at 1.5°C than at 2°C based on knowledge of past impacts. {3.3.1, 3.3.2}

- There is greater risk in the Arctic region with increasing level of global warming, for example, for ecosystems, permafrost and human systems. Such regions experience warming rates faster than the global average *(high confidence)*. (Figure SPM2) {3.3.3., 3.3.4, 3.4.9, 3.5.6, Box 3.5}

2.3 In the oceans, higher levels of temperature, acidification and hypoxia increase the risk to ecosystems and biodiversity. The loss of Arctic sea ice and the degradation of sub-tropical and tropical coral reefs are significantly larger at 2°C than at 1.5°C. {3.4, 3.4.4.1.4, 3.4.4.1.5, 3.4.4.1.6, 3.4.4.2, 3.4.4.2.1, 3.4.6.4, 3.5.2.4, Box 3.6, 3.7}

- Increased warming increases the risk of the Arctic Ocean being nearly ice free in September, with it being possible at 1.5°C global warming. {3.4.4.1.6}

- Global warming of 1.5°C leads to fundamental changes in ocean chemistry from which it may take many millennia to recover. At global warming of 1.5°C, ocean acidification is driving large-scale changes and amplifying the risks of temperature rise for ocean biological systems. Oceans are experiencing unprecedented changes with critical thresholds being reached at global warming of 1.5°C and above, for example driving some species to relocate and novel ecosystems to appear. Ecosystems that are relatively less able to move are projected to experience high rates of mortality and loss. {3.4.4.1.4, 3.4.4.1.5}

- Observed shifts in ocean biodiversity have major implications for food webs, ecosystem structure and services, fisheries, and human livelihoods. The risk of elevated local extinction rates in tropical regions is higher with 2°C of global warming compared to 1.5°C. (Figure SPM2) {3.4}

- Warm water coral reef ecosystems are losing live coral cover at present. They are at high risk that at 1.5°C and at 2°C they will no longer be dominated by corals. (Figure SPM2) {3.4.4.2.1}

- Marine ecosystem services, fisheries and aquaculture are already at risk today from ocean warming and acidification, and these impacts are projected to get progressively worse with global warming of 1.5°C, 2°C and higher. (Figure SPM2) {3.4.4.2, 3.4.6.4, 3.5.2.4, Box 3.6, 3.7}

2.4 On land, risks of local and regional species extinction, range loss and shifts in biodiversity distribution are lower at 1.5°C than at 2°C. {3.3.2.2, 3.4.3.1, 3.4.3.5, 3.5.2.4.2, 3.5.5.10}

- Risks for natural and managed ecosystems are amplified on drylands compared to humid lands. {3.3.2.2, 3.4.3.5, 3.5.5.10}

- Shifts in elevation and latitude of biomes in boreal, temperate, and tropical ecosystems have occurred with 1°C of warming (*high confidence*) and are attributable to anthropogenic climate change. Approximately 25% more biome shifts are projected to occur in the Arctic, Tibet, Himalayas, South Africa and Australia with 2°C global warming compared to 1.5°C. (Figure SPM3) {3.4.3.1}

- Local species extinction (extirpation) risks are higher in a 2°C warmer world, compared to 1.5°C. Climate-induced range losses in plants, vertebrates and insects increase by approximately 50% with 2°C global warming compared to 1.5°C (*medium confidence*). (Figure SPM2) {3.5.2.4.2}

2.5 Sea level will continue to rise for centuries. Sea level rise will be greater with 2°C global warming compared to 1.5°C, increasing risks to coastal ecosystems, infrastructure, and freshwater supplies. High risk levels and adaptation limits are expected to be reached earlier at 2°C compared to 1.5°C in many locations. {1.2.6, 3.3.12, 3.3.12.3, 3.4, 3.4.4.2.3}

- Past emissions do not commit to substantial future surface warming, but do commit to future sea level rise. It is *virtually certain* that sea level will continue to rise in both 1.5°C and 2°C worlds well beyond the end of the current century. {1.2.6, 3.3.12}

- Available studies suggest that global mean sea level rise by 2100 will be ~0.1m greater in a 2°C world compared to 1.5°C. Thresholds for irreversible, multi-millennial loss of the Greenland and West Antarctic ice sheets may occur at 1.5°C or 2°C global warming. The projected risk associated with long-term commitment to multi-metre-scale sea level rise is greater for a 2°C warmer world compared to 1.5°C. {3.3.12.3}

- The risks for hundreds of millions of people in coastal communities from eroding livelihoods, loss of cultural identity, ill health, and reduced coastal/mangrove protection are lower with global warming of 1.5°C compared to 2°C. (Figure SPM2) {3.4}

- Impacts associated with sea level rise and salinity changes to groundwater or estuaries are critically important in sensitive environments such as small islands. Preserving or restoring natural coastal ecosystems can be a more cost-effective protection of coastal regions from rising sea levels and intensifying storms compared to artificial interventions, such as building sea walls and coastal hardening. {3.4.4.2.3}

2.6 The risks to human societies through impacts on health, livelihood, food, and water security, human security, and infrastructure are higher with 1.5°C global warming compared to today, and higher still with 2°C global warming compared to 1.5°C. These risks are greatest for people facing multiple forms of poverty, inequality, and marginalisation; people in coastal communities and those dependent on agriculture; poor urban residents; and communities displaced from their homes. {3.4.6.2, 3.4.6.5, 3.4.7.2, 3.4.7.3, 3.4.4.2.3, 3.4.9.25.2.13.4.10.1, 3.4.10.2, 3.5.5.4, 3.5.5.5, Box 3.2, Box 3.3, Box 3.7, 5.2.2, 5.2.3, 5.6.3}

- Impacts of 1.5°C global warming will disproportionately affect already disadvantaged and vulnerable populations, particularly indigenous people and systems in the Arctic, agriculture- and coastal-dependent livelihoods, and small-island developing states. More severe impacts are expected where global temperature exceeds 1.5°C (*medium evidence*, *high agreement*). Limits to adaptation and associated losses exist at every level of temperature increase *(medium confidence)*, with place-specific implications, for example for Pacific Small Island Developing States (Figure SPM3) {5.2.1, 5.2.2, 5.2.3, 5.6.3}

- Globally, the poorest people are projected to experience the impacts of 1.5°C global warming predominantly through increased food prices, food insecurity and hunger, income losses, lost livelihood opportunities, adverse health impacts and population displacements. Such impacts can occur, for instance, from increased heat stress and other extreme events, such as coastal flooding, with over 100 million people projected to go into poverty through impacts on agriculture and food prices (*limited evidence, medium agreement*) {3.4.10.1, 5.2.2}

- Warming of 2°C poses greater risks to human health than warming of 1.5°C, often with complex regional patterns, with a few exceptions. Warmer temperatures are *likely* to affect the transmission of infectious diseases with increases and decreases projected depending on the disease (e.g., malaria, dengue, West Nile virus, and Lyme disease), region, degree of temperature change, and also *very likely* depending on the extent and effectiveness of additional adaptation and vulnerability reduction. (Figure SPM2, SPM3) {3.4.7.2}

- Constraining global warming to 1.5°C compared to 2°C reduces stress on global water resources by an estimated 50% (relative to 1980-2009), with reduced stress particularly in the Mediterranean region {3.4.10.2, 3.5.5.5, Box 3.2}.

- Risk to crop production in the Middle-East, Sub-Saharan Africa, South East Asia, and Central and South America, is reduced when global warming is limited to 1.5°C compared to 2°C. The risk for food production and extreme poverty is significant in these regions with 1.5°C global warming. {3.4.6.2, 3.5.5.4, 3.4.6.5, 3.4.7.3}

- Increasing temperatures will directly impact climate dependent tourism markets, including sun and beach and snow sports tourism (*high confidence*). {Box 3.3, Box 3.7, 3.4.4.2.3, 3.4.9.2}

2.7 Global warming of 1.5°C implies higher risks than today for the displacement of people, conflict, and surpassing limits to adaptation, though the level of risk is lower than at 2°C global warming. {3.4.6.2, 3.4.7.1, 3.4.10, 3.4.10.1, 3.4.10.2, 5.2, 5.2.1, 5.2.2}

- Limiting global warming to 1.5°C compared to 2°C or higher levels of warming will lower the risk of extreme events and threats to food and water security and hence lessen the potential for political struggles over scarce resources, which contributes to lessening human conflict. {3.4.10}

- Global warming above 1.5°C will worsen existing inequalities and increase poverty through ill health, increased food prices and hunger, mal- and under-nutrition, the erosion of livelihoods, displacement, and potential loss of what is meaningful for people's dignity and lives. {3.4.6.2, 3.4.7.1, 3.4.10.1, 5.2.1, 5.2.2}

- Disaster-related displacement is projected to increase over the 21st century with over 90% of disaster-related displacement between 2001 to 2015 related to climate and weather events *(medium confidence)*. {3.4.10.2}

- [Place holder: adaptation and limits to adaptation, and residual risks. {CH3, CH4, 5.2}]

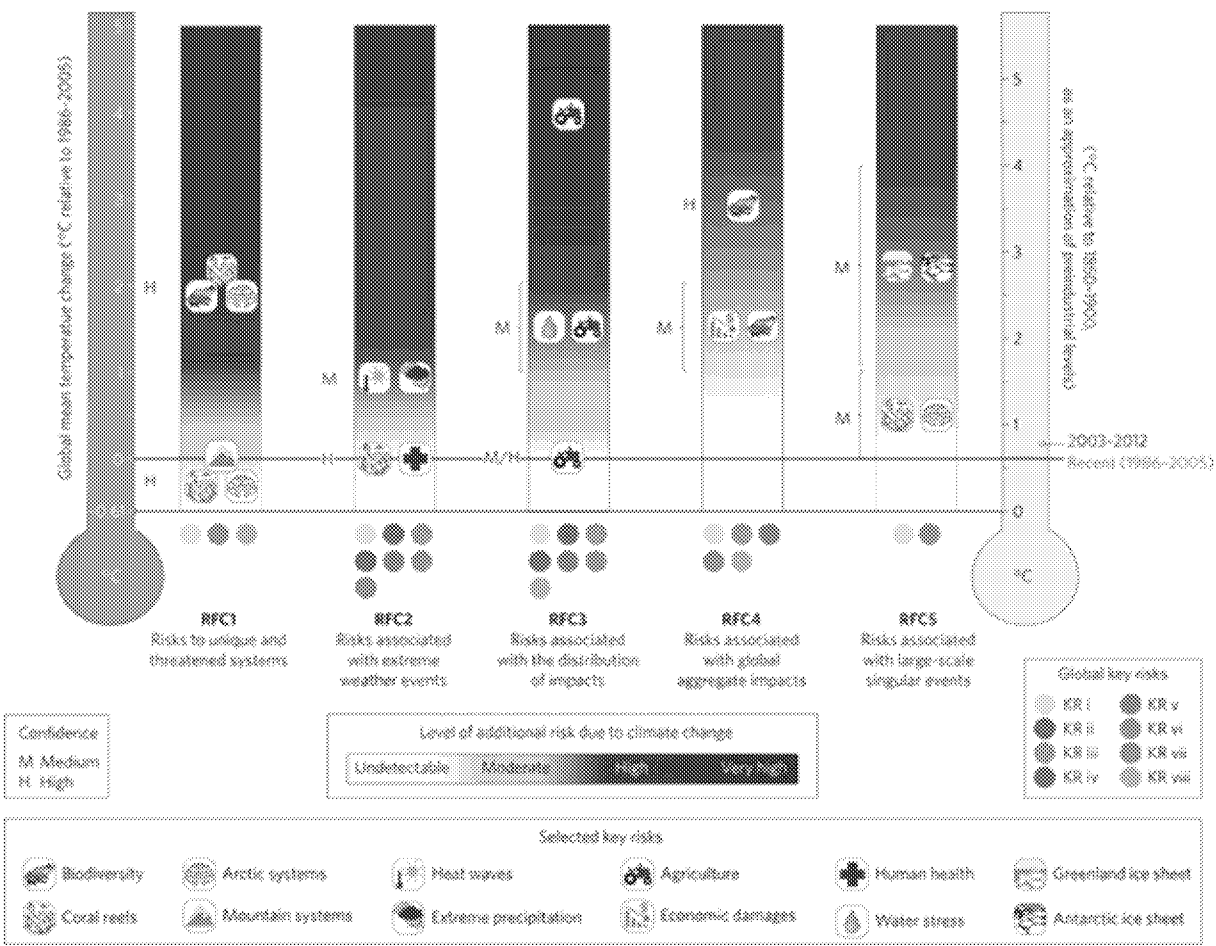


Figure SPM 2: [Placeholder] Levels of risk associated with 5 different reasons for concern are illustrated for increasing levels of global mean temperature and are the same as those presented in the IPCC AR5 Working Group II report. Icons indicate selected risks that played an important role in locating transitions between levels of risks. Coloured dots indicate overarching key risk

categories that were considered in the assessment for each reason for concern (RFC)[4]. Confidence in the judgments of risk transitions is indicated as medium (M) or high (H) and the range over which transitions take place is indicated with brackets. For example, for RFC1 there is *high confidence* in the location of the transition from Undetectable to Moderate risk, which is informed by impacts to coral reef, Arctic and mountain systems; and there is *high confidence* in the location of the transition from High to Very High risk, which is informed by impacts to coral reef and Arctic systems as well as to species associated with unique and threatened systems. This assessment takes autonomous adaptation into account, as well as limits to adaptation (RFC 1, 3, 5) independently of development pathway. [To be updated and developed to highlight more clearly the recent literature on the differences between risks for 1.5°C/2°C warming].

[4] Key risk categories (O'Neill et al., 2017): (i) Risk of death, injury, ill-health, or disrupted livelihoods in low-lying coastal zones and small island developing states and other small islands due to storm surges, coastal flooding, and sea-level rise. (ii) Risk of severe ill-health and disrupted livelihoods for large urban populations due to inland flooding in some regions. (iii) Systemic risks due to extreme weather events leading to breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services. (iv) Risk of mortality and morbidity during periods of extreme heat, particularly for vulnerable urban populations and those working outdoors in urban or rural areas. (v) Risk of food insecurity and the breakdown of food systems linked to warming, drought, flooding, and precipitation variability and extremes, particularly for poorer populations in urban and rural settings. (vi) Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi-arid regions. (vii) Risk of loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for coastal livelihoods, especially for fishing communities in the tropics and the Arctic. (viii) Risk of loss of terrestrial and inland water ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for livelihoods.

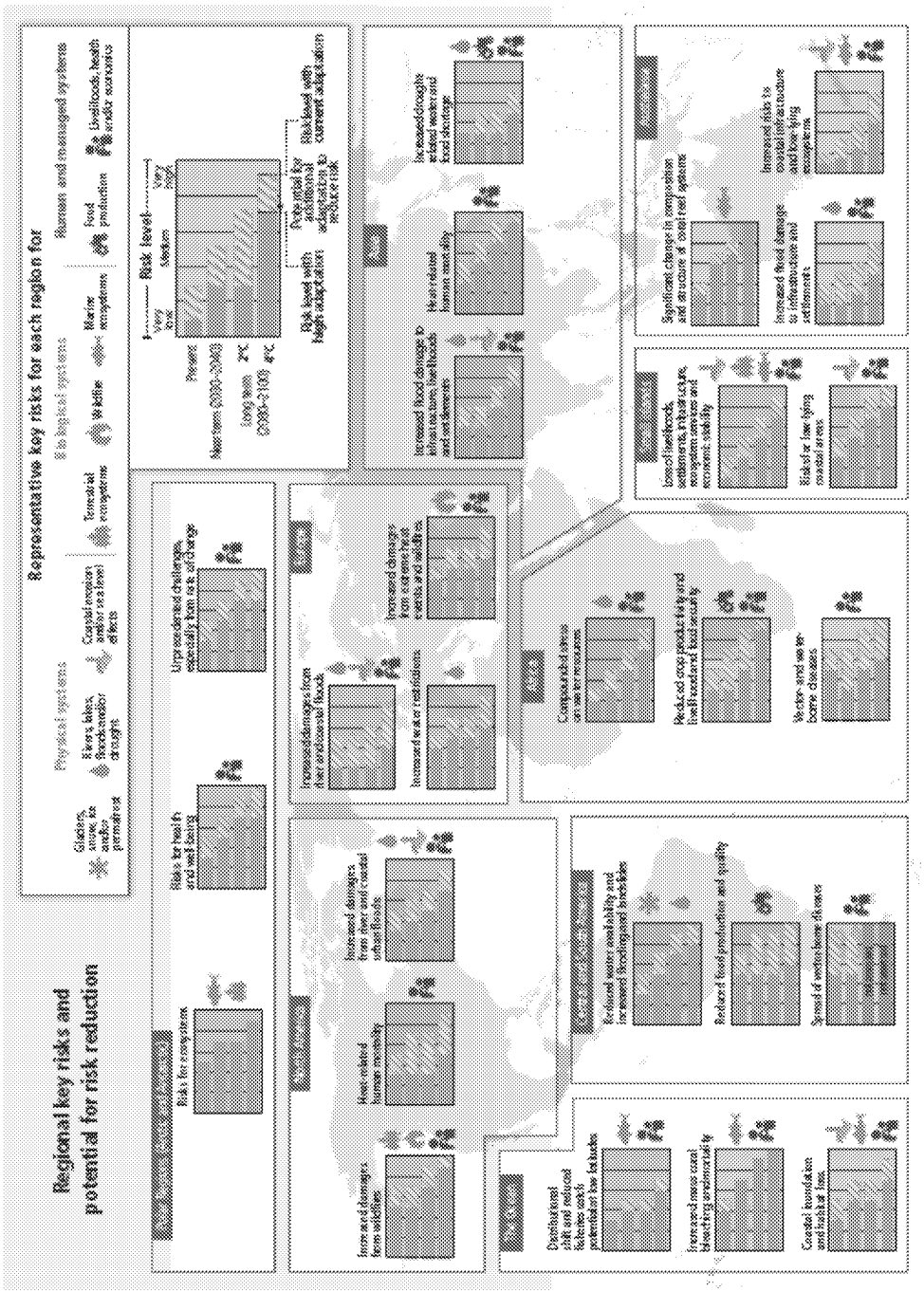


Figure SPM 3: [Place holder – AR5 SYR Figure SPM.8 and caption] Representative key risks for each region, including the potential for risk reduction through adaptation and mitigation, as well as limits to adaptation. Each key risk is assessed as very low, low, medium, high or very high. Risk levels are presented for three time frames: present, near term (here, for 2030–2040) and long term (here, for 2080–2100). In the near term, projected levels of global mean temperature increase do not diverge substantially across different emission scenarios. For the long term, risk levels are presented for 2°C global temperature increase above pre-industrial levels. For each timeframe, risk levels are indicated for a continuation of current adaptation and assuming high levels of current or future adaptation. Risk levels are not necessarily comparable, especially across regions. Identification of key risks was based on expert

judgment using the following specific criteria: large magnitude, high probability or irreversibility of impacts; timing of impacts; persistent vulnerability or exposure contributing to risks; or limited potential to reduce risks through adaptation or mitigation. [To be adapted according to Chapter 3 outcomes. Risk assessment for +4°C to be dropped.]

SPM 3 Emission pathways and policy responses compatible with 1.5°C global warming

3.1 The assessed literature identifies potential emission pathways consistent with limiting global warming to 1.5°C. Some pathways hold warming below 1.5°C throughout the 21st century while in others global warming overshoots 1.5°C before returning to 1.5°C by 2100. {1.2.2, 2.1.3, 2.2.2, 2.3.2, 2.3.4, 2.2.5, 2.5.1, 2.5.2, 2.6.2, 4.3.8, Cross-Chapter Box 4.1}

- Limiting global mean warming to 1.5°C would require rapid and deep reductions in greenhouse gas emissions, even with a temporary overshoot and later return to 1.5°C. The Nationally Determined Contributions (NDCs) submitted under the Paris Agreement will result, in aggregate, in global greenhouse emissions in 2030 which are higher than those in scenarios compatible with global warming of 1.5°C by 2100 *(high confidence)*.

- Because of the cumulative impact of CO_2 emissions, any delay in emission reductions (including the delay implied by the post-2020 start date of the NDCs) significantly increases the risk associated with a temperature overshoot and would require faster subsequent emissions reductions and/or more CO_2 removal. CO_2 removal can accelerate the decline of CO_2 emissions to help avoid a temperature overshoot, and in scenarios where a temperature overshoot occurs, active net CO_2 removal is required to achieve a global mean temperature of 1.5°C by the end of the 21st century *(high confidence)*. {1.2.2, 2.3.1, 2.3.4, 2.2.5, 4.3.8, Cross-Chapter Box 4.1}

- Based on integrated assessment models, historical emissions, current policies and patterns of investment have already placed scenarios limiting warming below 1.5°C without overshoot with at least 66% likelihood out of reach. *(medium confidence)*. {2.1.3, 2.3.2, 2.5.1, 2.5.2}

- Uncertainties remain in radiative forcings and Earth system feedbacks. For a given emission scenario, these uncertainties increase the risk of global warming exceeding 1.5°C *(medium confidence)*. {2.2.2, 2.6.2}

3.2 Cumulative future CO_2 emissions compatible with avoiding a given level of global warming are often referred to as carbon budgets. Carbon budgets depend on the likelihood of avoiding a given level of global warming. They also account for changes in non-CO_2 climate forcers, such as methane and aerosols. Carbon budgets may refer to cumulative emissions from 2016 until peak warming or until warming returns to 1.5°C after a temporary overshoot. {2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.4.2, 2.5.1, 2.6.1, 2.6.2}

- Two types of carbon budgets are used in this assessment. The threshold peak budget is defined as the cumulative CO_2 emissions from 1 January 2016 until the time that the global mean temperature peaks at (or below) 1.5°C or 2°C. The threshold return budget is defined as the

cumulative CO_2 emissions from 1 January 2016 until the time that global mean temperature returns to 1.5°C or 2°C after a temperature overshoot. Both types of carbon budget account for non-CO_2 climate drivers (Table SPM1, Figure SPM4). {2.1.3, 2.2.1, 2.6.1, 2.6.2}

- The threshold peak budget compatible with a 50% likelihood of limiting warming to 1.5°C without overshoot is estimated to be 580 (490-640) $GtCO_2$ (Table SPM1). This budget would be exhausted in 12-16 years if emissions were to continue at 2015 levels, and thus it would be impossible, at that point, to limit global warming to 1.5°C without overshoot. {2.2.2}

- The expected magnitude of future warming from non-CO_2 drivers depends on the emission pathway. In the 5% of emission pathways that experience the greatest warming due to non-CO2 drivers, there is a 3% chance that the 1.5°C threshold peak budget is already exhausted and a 25% chance that the threshold return budget is already exhausted. The likelihood that the threshold return budget is exhausted is reduced to less than 1% in scenarios with the most ambitious mitigation pathways for non-CO_2 warming agents *(medium confidence)*. (Figure SPM3, SPM4) {2.2.2, 2.3.1, 2.4.2, 2.5.1}

- If emissions of non-CO_2 climate drivers are not significantly reduced, there is a higher than 66% likelihood that global temperature will exceed 1.5°C, even with the most stringent CO_2 mitigation considered in 1.5°C scenarios *(medium confidence)*. {2.2.2, 2.3.1, 2.4.2, 2.5.1}

	Likelihood of limiting warming	**Threshold Return Budgets $GtCO_2$**	**Threshold Peak Budgets $GtCO_2$**
Limiting warming to 1.5°C	50% likelihood	590 (420–880)	580 (490–640)
	66% likelihood	390 (200–730)	*Not Available*
Limiting warming to 2°C	50% likelihood	960 (570–1460)	1450 (1330–1550)
	66% likelihood	910 (570–1210)	1180 (1050–1380)

Table SPM 1: Two types of remaining carbon budgets based on available scenarios and compatible with different likelihoods of limiting warming to 1.5°C or 2°C. Median and likely range due to geophysical uncertainty (around median non-CO_2 contribution) of Threshold Peak Budget (*medium confidence*) and Threshold Return Budget (*medium confidence*) in $GtCO_2$ compatible with 1.5°C or 2°C for the 1st January 2016 onwards[5]. {Table 2.4}.

[5] Budgets are computed assuming that warming is limited to 1.5°C with either 50% likelihood or 66% likelihood and accounting for non-CO_2 drivers. Budget ranges are based on available scenarios and span physical uncertainty arund the median achievement of non-CO_2 emission reductions.

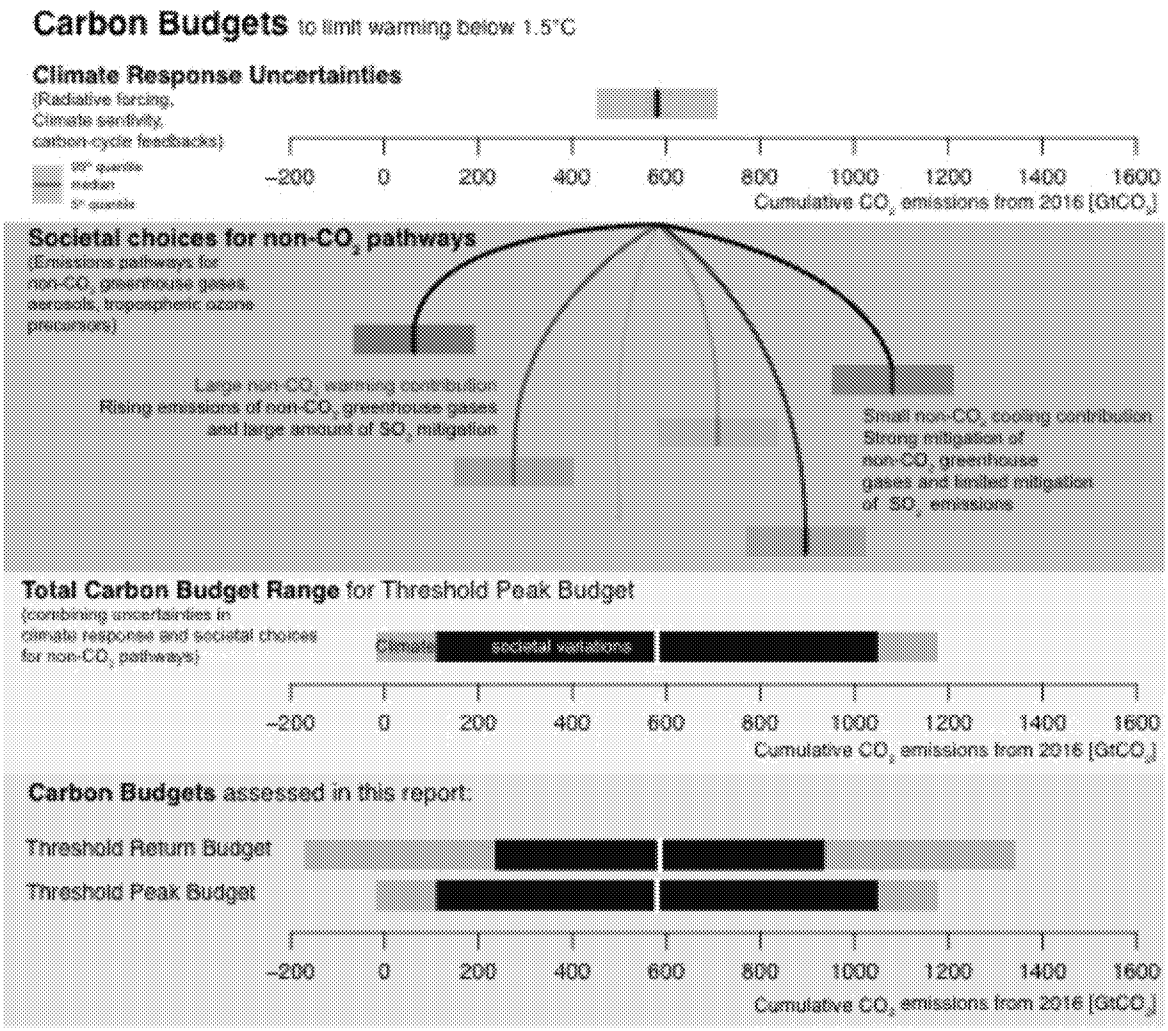


Figure SPM 4: Summary of the various uncertainties affecting carbon budget size for holding warming below 1.5°C relative to preindustrial levels from the 1st January 2016 onwards. For threshold peak budget best estimate of 580 $GtCO_2$ as given in Table SPM 1, the climate response uncertainties associated to this budget are represented by the 5%-95% confidence interval inferred from outcomes due to variation of geophysical parameters in the simple climate model setup used for this assessment. Uncertainties in climate response include those associated to radiative forcing, climate sensitivity, and carbon-cycle feedbacks. Societal choices influencing the carbon budget size are related to societal variations for non-CO_2 forcing which are illustrated by the full range of forcing futures found in the integrated pathways available in the SR1.5 scenarios database. A "large non-CO_2 warming contribution" represents 0.85 W m^{-2} of non-CO_2 radiative forcing at the time of deriving the carbon budget, a "small non- CO_2 cooling contribution" represents -0.02 W m^{-2} of non-CO_2 radiative forcing. The median non- CO_2 radiative forcing estimate across all available pathways is 0.45 W m^{-2} of non-CO_2 radiative forcing. The total carbon budget range provides an overview of the combined uncertainties in threshold peak budget due to the aforementioned factors. Median threshold peak budgets and threshold return budgets as given in Table SPM 1 are indicated by the vertical bold white line in the bottom panel.

3.3 All emission pathways compatible with a 50% or higher likelihood of limiting global warming to 1.5°C by 2100 imply rapid reductions in global CO_2 emissions, reaching net zero around or shortly after the middle of the 21st century. Such pathways also imply stringent reductions in non-CO_2 climate forcers, primarily methane, black carbon and hydrofluorocarbons. {1.3, 1.2, 2.2.2, 2.4.1, 2.3.1, 2.3.4, 2.5.3}

- 1.5°C scenarios involve deep reductions in global CO_2 emissions and must reach net zero before global warming reaches 1.5°C. They also involve deep reductions in non-CO2 drivers. *(high confidence)*. {1.3, 1.2, 2.2.2, Table 2.7, 2.4.1, 2.3.1, 2.3.4. 2.5.3}

- Because of the cumulative impact of global CO_2 emissions, any initial delay in emission reductions requires faster subsequent reductions to meet the same temperature ambition, or subsequent active net CO_2 removal to reduce temperatures following a temperature overshoot. {1.2}

3.4 All 1.5°C emission pathways involve rapid and extensive transitions in energy systems, urban systems, and patterns of land use. More extensive and rapid transitions in these systems would lower the requirement for CO_2 removal in the second half of the 21st century. {2.1.3, 2.3.1, 2.3.2, 2.3.4, 2.4.1, 2.4.2, 2.4.3, 2.5.1, 2.5.2, 4.2, 4.2.2, 2.3.4, 4.4}

- Modelled pathways for remaining below 1.5°C require rapid rates of change in emissions. Historically, rapid rates of change have been observed temporarily and in some sectors, for example, electricity supply. There is, however, no documented precedent for the geographical and economic scale of the energy, land, urban and industrial transitions implicit in pathways consistent with a 1.5°C warmer world has no documented historic precedents. Such transitions require more planning, coordination and disruptive innovation across actors and scales of governance than the spontaneous or coincidental changes observed in the past (*medium agreement, medium evidence*). {4.2, 4.2.2, 4.4}

- In 1.5°C scenarios, mitigation options are deployed more rapidly, at greater scale, and with a more complete portfolio of possible mitigation options deployed than in 2°C scenarios. {2.3.4, 2.4.1, 2.4.2, 2.4.3}

- Delayed action or weak near-term policies increase the likelihood of exceeding the 1.5°C target and the amount of stranded investment in fossil-based capacity, leading to higher long-term mitigation challenges *(high confidence)*. {2.1.3, 2.3.2, 2.5.1, 2.5.2}.

- In 1.5°C pathways rapid and extensive mitigation as well as CO_2 removal occur simultaneously. Such pathways generally rely more heavily on additional mitigation measures than they do CO_2 removal. Compared to 2°C pathways, additional mitigation measures account for around two thirds of the ~600 $GtCO_2$ of CO_2 reductions by the end of the century, and CO_2 removal for the remaining third (~180 $GtCO_2$ for the median). {2.3.1, 2.3.4}

3.5 All mitigation pathways compatible with limiting global warming to 1.5°C by 2100 involve removal of CO_2 from the atmosphere. Scenarios with high overshoots, where global warming may reach up to 1.9°C before returning to 1.5°C by 2100, involve more CO_2 removal than scenarios that keep overshoot as low as possible. There is a high chance that the levels of CO_2 removal implied in the scenarios might not be feasible due the required scale and speed of deployment required and trade-offs with sustainable development objectives. {2.2.2, 2.4.1, 2.3.1, 2.3.3, 2.3.4, 2.4.2, 2.4.4, 2.5.3, 2.6.4, 4.3.8}

- All the 1.5°C pathways analysed use CO_2 removal in some form to compensate for emissions from sectors for which no mitigation measures have been identified. {2.2.2, Table 2.7, 2.4.1, 2.3.1, 2.3.4. 2.5.3}

- The total amount of CO_2 removal projected in 1.5°C pathways in the literature is of the order of 380-1130 $GtCO_2$ over the 21st century. 25-85% of this CO_2 removal is used to compensate for emissions for which no mitigation measures have been identified, while the remainder is used after carbon neutrality has been achieved to compensate for exceeding the carbon budget prior to that point *(medium confidence)*. {2.3.1, 2.6.4}

- The required scale of CO_2 removal depends on emissions reductions in the coming decades and the degree by which they exceed the 1.5°C carbon budget. {2.3.1}

- Biomass demand is substantial in all 1.5°C pathways due to its multiple energy uses and CO_2 removal potential. The future availability of, and demand for, biomass is closely linked to land use transitions and transitions in other sectors.

- All 1.5°C pathways include the option of CO_2 removal measures such as afforestation and/or biomass energy with carbon capture and storage (BECCS). Other options, such as direct air capture and storage, are in early stages of development or need significant upgrading to be effective mitigation options and are not typically included in current scenarios. BECCS is deployed as early as 2020 in some scenarios but is not deployed at all in others. Both BECCS and afforestation have implications for how land is used to produce biomass through the growth of trees and energy crops or to store CO_2 in vegetation and soil *(high confidence)*. {2.3.3, 2.4.2, 2.4.4, 2.5.3, 4.3.8}

- Measures that lead to a net removal of CO_2 from the atmosphere are affected by multiple feasibility constraints. For example, increased biomass production and use has the potential to increase pressure on land and water resources, food production, biodiversity, and to affect air-quality. Therefore, the scale and speed of implementation assumed in some 1.5°C pathways may be challenging (*high agreement*). {2.3.3, 2.4.2, 2.4.4, 2.5.3, 4.3.8}

3.6 Some patterns of development, for example those that involve high population growth, slow economic development, and limited capacity to transform energy, urban and land use systems, increase the chance that holding global warming to 1.5°C by 2100 is beyond reach, causing associated risks. The extent and speed of required mitigation efforts are related to the underlying pace and nature of development, political will, behaviour and lifestyle. {2.3.1, 2.3.4, 2.4.1, 2.4.2, 2.4.3, 2.3.5, 2.5, 2.5.1, 2.5.2, 4.4.1, 4.4.4.3, 4.4.5, 5.4, 5.6}

- The transformations necessary to limit warming to 1.5°C are qualitatively similar to those for a 2°C limit, but more pronounced and rapid over the next decades *(high confidence)*. Limiting global warming to 1.5°C rather than 2°C implies a more complete portfolio of mitigation measures, faster socio-technical transitions, and more ambitious international policies in the short term that target both supply and demand *(very high confidence)*. Such transformations would involve rapid and large scale behaviour and lifestyle change *(very high confidence)*. {2.3.1, 2.3.4, 2.4.1, 2.4.2, 2.4.3, 2.3.5, 2.5, 2.5.1, 2.5.2, 4.4.1, 4.4.4.3, 4.4.5}

- Sustainable development, the Sustainable Development Goals and well-being for all will be difficult to achieve without sufficient consideration of the equity and ethics of such rapid and deep transformations, as well as their social and political feasibility. {5.4, 5.6}.

3.7 Issues related to governance and ethics, public acceptability and impacts on sustainable development could render solar radiation management economically, socially and institutionally infeasible. {4.3.9, 4.4.1, 4.4.4, 4.4.5, Cross-Chapter Box 4.2}

- While none of the pathways assessed in the Special Report include solar radiation management, solar radiation management has been considered in the context of reducing temperature-related impacts of global warming, while other impacts, such as those related to ocean acidification, would largely remain unaffected. Even in the uncertain case that some of the adverse side effects of solar radiation management could be avoided, multi-level governance issues, ethical implications, public resistance and impacts on sustainable development could render solar radiation management economically, socially and institutionally infeasible. {4.4.1, 4.4.4, 4.4.5}

- Uncertainties related to solar radiation management include technological maturity, physical understanding, efficiency to limit global warming, and the ability to scale, govern and legitimise their potential implementation. (*low agreement, medium evidence*). {4.3.9, Cross-Chapter Box 4.2}

SPM 4 Strengthening the global response in the context of sustainable development and efforts to eradicate poverty

4.1 There is very high likelihood that under current emission trajectories and current national pledges the Earth will warm globally more than 1.5°C above preindustrial levels, causing associated risks. The nationally determined contributions submitted under the Paris Agreement will result, in aggregate, in global greenhouse emissions in 2030 which are higher than those in scenarios compatible with limiting global warming to 1.5°C by 2100. More ambitious pledges would imply higher mitigation costs in the short-term, albeit offset by a variety of co-benefits, but would lower both mitigation and adaptation costs in the long-term. {2.3.1, 2.3.1.1, 2.3.5, 2.5.1, 2.5.2, 4.2.1, 4.4, 4.4.1, 4.4.2, 4.4.6, Cross-Chapter Box 4.1, 5.4.2}

- Following current nationally determined contribution pledges, no scenario can be produced that allows for the interactions between the energy, economic, and land-use systems that

would be required to limit global warming to below 1.5°C. {2.3.1.1, 2.3.5, Table 2.7, Cross-Chapter Box 4.1}

- There is very high likelihood that under current emission trajectories and current national pledges until 2030, global warming will reach 1.5°C above preindustrial levels by mid-century and remain above that level even in 2100, causing associated risks *(high confidence)*. {1.2.6, 2.3.1, 2.3.5, 2.5.1}

- The transition and adaptation to a world in which global warming is limited to 1.5°C can only be realized by upscaling and accelerating the implementation of rapid, far-reaching, multi-level and cross-sectoral climate mitigation and adaptation actions, integrated with sustainable development initiatives (*high agreement, medium evidence*) (Box SPM 2). {Cross-Chapter Box 4.1, 4.2.1, 4.4}

- Delaying actions to reduce greenhouse gas emissions increases the risk of cost escalation, stranded assets, job losses, and reduced flexibility in future response options in the medium to long-term. These may increase uneven distributional impacts between countries at different stages of development (*medium evidence, high agreement*). {5.4.2}

- To strengthen implementation of the global response, all countries would need to significantly raise their level of ambition, shift financial flows and investment patterns, improve coherence in governance, address equity across and between generations and regions, and strengthen capacities, including traditional knowledge. (*medium agreement, high evidence*). {2.5.2, 4.4.1; 4.4.2, 4.4.6}

4.2 Energy transitions in pathways compatible with limiting global warming to 1.5°C by 2100 involve end-use efficiency improvements, reductions in energy demand, a rapidly growing share of renewable energy and other low carbon energy supplies, and electrification of end-use. These changes also occur in 2°C scenarios, but each element of the energy transition occurs more rapidly and at a greater scale in 1.5°C scenarios. {2.3.3, 2.3.4, 2.4, 2.5.1, 2.5.2, 4.3.2, 4.3.5, 4.3.2, 2.4.3, 4.4.3, 4.4.5, 5.4.1, 5.4.3, 5.4.2}

- Energy transitions are currently taking place in many sectors and regions around the world, but at a slower pace in energy-intensive industry and international transport (*high agreement, medium evidence*). {4.3.2, 4.3.5, 4.3.2}

- Final energy demand in 2100 is generally 20-60% higher relative to 2014 levels across available 1.5°C scenarios. However, energy demand lower than present day, together with strong growth in economic output until the end of the century, is found in scenarios with shifts to more sustainable energy, material and food consumption patterns. {2.4.3, 4.4.5, 4.4.3}

- Large reductions of per capita energy demand in areas with high consumption are critical elements of 1.5°C scenarios. These are accompanied by increased efficiency in end uses (e.g. appliances, industrial processes, insulation, lighter vehicles, etc.) and often by substantial decreases in per capita livestock demand, demand for private vehicle transportation, food waste and deforestation. *(medium confidence)*. {2.3.4, 2.4}

- 1.5°C scenarios include rapid electrification of energy end use (about two thirds of final energy by 2100), and rapid decreases in the carbon intensity of electricity and of remaining fossil fuel use *(high confidence)*. The electricity sector is fully decarbonized by mid-century in both 1.5°C and 2°C pathways. Additional emissions reductions compared to 2°C pathways come predominantly from energy end use sectors (transport, buildings, industry). {2.3.3}

- The share of primary energy from renewables increases rapidly in most 1.5°C pathways, with renewables becoming the dominant source by 2050. Low-carbon energy, which includes renewable energy, sustainable biomass and nuclear, supplies on average about one third (15-87% full scenario range) of primary energy in 2030 and on average about two thirds (36-97% range) in 2050.

- Coal use would be phased out rapidly in most 1.5°C pathways with annual reduction rates of 4-5%. In pathways where coal use is not entirely phased out by 2050, it is combined with carbon capture and storage and there is virtually no unabated coal use. Most 1.5°C pathways indicate slowly declining use of oil, and a wide range of natural gas use with varying levels of carbon capture and storage.

- A broad portfolio of different mitigation policy options, including carbon pricing mechanisms and regulation, would be necessary in 1.5°C pathways to achieve the most cost-effective emissions reductions *(high confidence)*. Reduction in energy demand can also be achieved through behaviour change. Discounted carbon prices for limiting warming to 1.5°C are three to seven times higher compared to 2°C, depending on models and socioeconomic assumptions *(medium confidence)*. {2.5.1, 2.5.2, 4.4.5, 4.4.3}

- The choice of the portfolio of mitigation options and the policy instruments that are used for implementation will largely determine the overall synergies and trade-offs of 1.5°C mitigation pathways for sustainable development *(very high confidence)* (Figure SPM5) {5.4.1,5.4.3, Figure 5.4.1, 5.4.2}.

Sector	Changes by 2050 compared to 2010 in Chapter 2	Decreased energy use compared to the reference scenario	Decreased energy use compared to a 2ºC pathway
Transport	[22%] increase in final energy use [36%] share of low-emission energy (electricity, hydrogen, biofuels)	[39%]	[17%]
Buildings	[20%] reduction in final direct energy use [60% electrification	[22%]	[8%]
Industry	[16%] increase in final energy use [86%] reduction coal use [36%] electrification 0.8-1.8 $GtCO_2$ avoided yr^{-1} by CCS (median: 1.5)	[28%]	[20%]
Electricity	Almost zero-emission by 2050 (some coal/gas with CCS still allowed)	Not Available	Not Available

Note: Sectoral changes are based on the median across the range of assessed pathways

Table SPM 2: [Place holder] Sectoral changes by 2050 consistent with 1.5ºC pathways based on section 2.4. Increasing energy use in end-use sectors is due to higher activity levels. The columns "Decreased energy used compared to REF" and "Decreased energy use compared to a 2ºC

pathway" indicate that considerable cuts in energy use would be made compared to the reference scenario and to a 2°C scenario. {Table 4.1}

4.3 Pathways compatible with limiting global warming to 1.5°C by 2100 involve land transitions that imply increasing use of land for sustainable bioenergy production and carbon storage. There is also a need for large volumes of sub-surface carbon storage. Land use mitigation and adaptation options are interlinked with regional climate, food systems, dietary patterns, forest management, regional climate, biodiversity, ecosystems service provision and the Sustainable Development Goals. {Chapter 3, 3.7.2.1, 4.3.3, 4.3.6, 4.3.8, 4.4.3, 4.4.5, 4.5.3, 5.4.1.2, 5.4.1.5}

- Global and regional land-use and ecosystem transitions in 1.5°C pathways lead to impacts on agricultural and natural resource-dependent livelihoods *(medium agreement, medium evidence)*. If not managed carefully, significant changes in agriculture and forest systems risk weakening ecosystem health, leading to food, water and livelihood security challenges, reducing social and environmental feasibility of land-use related mitigation options. {Chapter 3, 4.3.3, 4.3.8, 4.5.3}

- Land use is an important driver of regional climate. Biophysical climate feedbacks of land use change are not considered in the development of the socio-economic pathways. {3.7.2.1}

- Agriculture, forestry and other land use mitigation options that take into account local people´s needs, biodiversity and other sustainable development concerns provide large synergies with Sustainable Development Goals particularly within rural areas of developing countries (*high confidence*). {5.4.1.2, 5.4.1.5}

- Changing agricultural practices using principles of conservation agriculture, efficient irrigation, and mixed crop-livestock systems are effective adaptation strategies. Behavioural change around diets would reduce emissions and pressure on land. {4.3.3, 4.4.3, 4.4.5, 4.5.3}

- Several overarching adaptation options that are closely linked to sustainable development can be implemented across rural landscapes, such as investing in health, social safety nets, and insurance for risk management, or disaster risk management and education-based adaptation options. {4.3.6, 4.5.3}

4.4 Limiting global warming of 1.5°C implies the need for transformational adaptation and mitigation, behaviour change, and multi-level governance. The implementation of far reaching measures is limited by institutional and innovation capabilities. {1.4, 2.3.4, 2.4, 2.5.1, 2.5.2, 4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5, 4.5.4, 5.4.1, 5.4.1.3, 5.6.4}

- The feasibility of limiting warming to 1.5°C in this report is addressed by considering the capacity to achieve a specific goal or target, requiring the integration of natural system considerations into the human system scenarios, the placement of technical transformations into their political, social, and institutional context. {4.5.4}

- Public and formal institutional and innovation capabilities are a limiting factor almost everywhere around the world, particularly in Least Developed Countries and and among

populations facing multidimensional poverty, persistent inequalities, and high vulnerabilities. This results in a scarcity of the critical mass of actors needed for the implementation of far reaching measures (*high agreement, medium evidence*). {4.4.1, 4.4.2, 4.4.4, case studies in 4.4, 5.6.4}

- Economies dependent upon fossil fuel-based energy generation and/or export revenue will be affected by the reduced use of fossil fuels necessary to meet ambitious climate goals, despite multiple other sustainable development benefits. There is a need for supplementary policies, including retraining, to ease job losses and the effects of higher energy prices, when they occur, particularly in developing countries where the workforce is largely semi- or unskilled (*very high confidence*) {5.4.1.3}.

- A broad portfolio of different mitigation policy options, including carbon pricing mechanisms and regulation, information provision and technological and infrastructural changes are necessary in 1.5°C pathways to achieve the most cost-effective emissions reductions *(high confidence)*. {2.5.1, 2.5.2, 4.4.1, 4.4.3, 4.4.5}

- Packages of policy instruments targeting key factors enabling and promoting change, working across governance levels and promoting innovation, are needed to implement a rapid and far-reaching response *(medium agreement, medium evidence)*. Policy instruments, both price and non-price, are needed to accelerate the deployment of carbon-neutral technologies. Evidence and theory suggests that some form of carbon pricing can be necessary but insufficient in isolation *(medium agreement)*. {2.5.1, 2.5.2, 4.4.3, 4.4.4, 4.4.5}

- Transitioning from climate change mitigation and adaptation planning to practical implementation is a major challenge in constraining global temperature to 1.5°C. Barriers include finance, information, technology, public attitudes, special interests, political will, social values and practices and human resource constraints plus institutional capacity to strategically deploy available knowledge and resources. {1.4, 4.4.1, 4.4.3}

- Policy and finance actors may find their actions to limit warming to below 1.5°C more cost-effective and acceptable if multiple factors affecting behaviour are considered (*high agreement, medium evidence*). Behaviour- and lifestyle-related measures have led to limited emission reductions and have promoted effective adaptation behaviour around the world *(high confidence)*. {2.3.4, 2.4, 4.4.1, 4.4.3, Figure 4.4}

- Mitigation actions in the energy demand sectors and behavioural response options with appropriate management of rebound effects can advance multiple Sustainable Development Goals simultaneously, more so than energy supply side mitigation actions *(very high confidence)*. (Figure SPM5) {5.4.1, Table 5.1 a-c, Figure 5.4.1}

- Multi-level governance in a 1.5°C warmer world can create an enabling environment for mitigation and adaptation options, behavioural change, policy instruments and innovation, and be aligned with the political economy of both adaptation and mitigation (*medium agreement, medium evidence*). However, power asymmetries undermine the rights, values, and priorities of disadvantaged populations in decision making *(high confidence)*. {4.4, 4.4.1, 5.5, 5.6}

4.5 Pathways that are consistent with limiting global warming to 1.5°C target energy efficiency and demand provide strong synergies between sustainable development and mitigation actions. These actions can bring high synergies for water and air quality, public health, and terrestrial and marine ecosystems. The risks for poverty, hunger and energy access of mitigation measures can be alleviated by redistributive measures. {2.3, 2.5, 4.3.7, Boxes 4.1, 4.2 and 4.3, 5.4.1, 5.4.1.3, 5.4.1.4, 5.4.1.5, 5.4.2, 5.4.2.2, 5.4.3}

- Mitigation options that emerge from cross-sectoral efforts at city scale show enhanced synergies with Sustainable Development Goal, as well as those emerging from new sectoral organisations based on the circular economy concept such as zero waste, decarbonisation and dematerialisation, and multi-policy interventions following systemic approaches *(medium evidence, high agreement)*. {Boxes 4.1, 4.2 and 4.3, 5.4.1.4}.

- Pathways limiting global warming to 1.5°C with options to reduce short-lived climate forcers, such as methane, black carbon and short-lived hydrofluorocarbons, have co-benefits for sustainable development in terms of health through the prevention of air pollution. However, reducing sulphates and other cooling air pollutants comes with trade-offs for reducing warming. (Figure SPM4, SPM6) {2.3, 2.5, 4.3.7, 5.4.1.5}

- Pathways limiting global warming to 1.5°C that feature very low energy demand show pronounced positive effects across multiple Sustainable Development Goals (*very high confidence*), though increased risk of sustainable development trade-offs, notably those that affect poor and indigenous populations. They assume radical socio-cultural and organizational innovation, which can create challenges for social acceptability. (Figure SPM5, Figure SPM6, Box SPM 2) {5.4.1.3, 5.4.2.2, Table 5.1}

- Policy designs and measures can reduce trade-offs between mitigation options compatible with 1.5°C warming and achieving sustainable development and the Sustainable Development Goals (*high confidence*). {5.4.1, 5.4.3, Figure 5.4.1, 5.4.2}

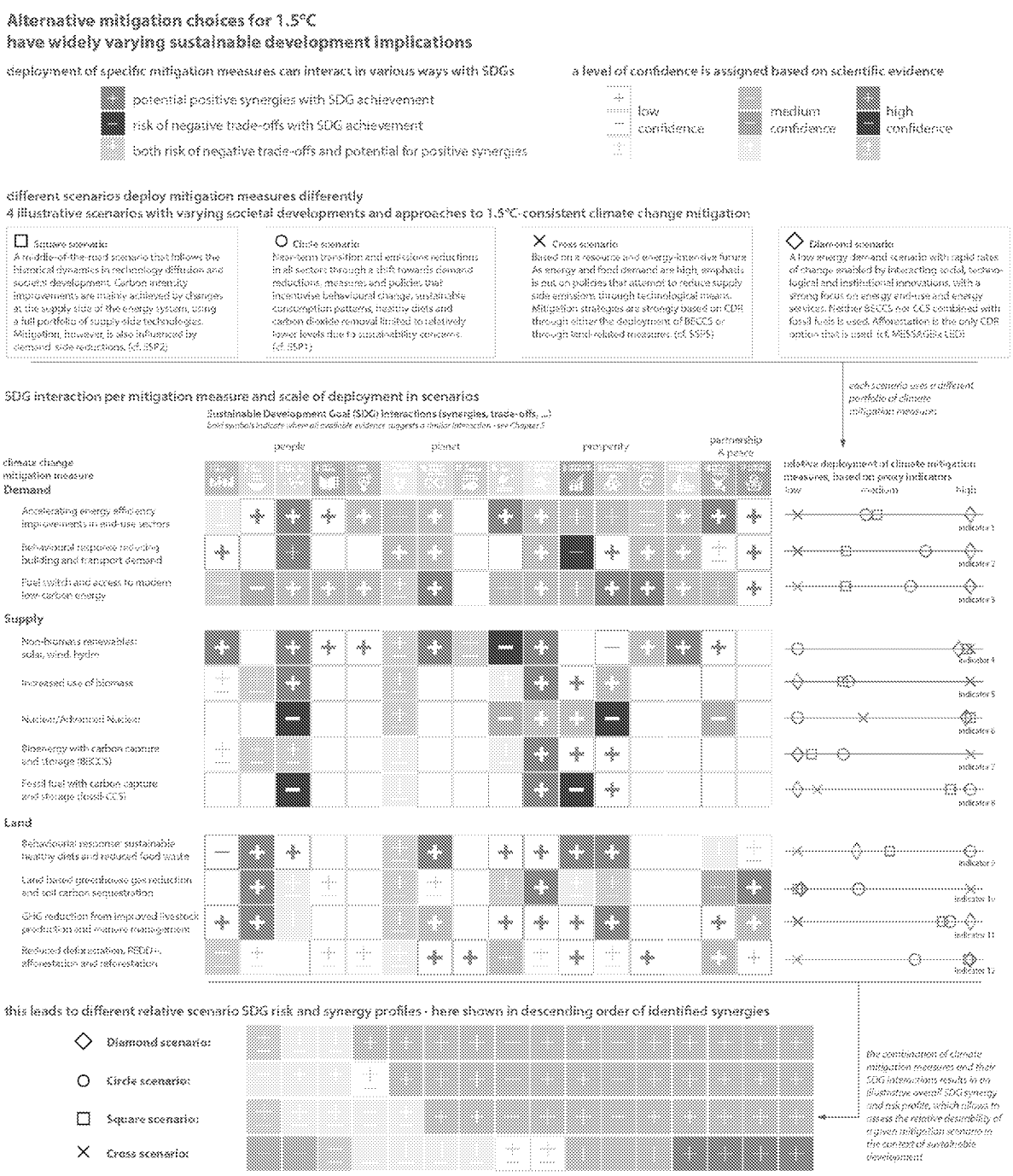


Figure SPM 5: Interactions of individual mitigation measures and alternative mitigation portfolios for 1.5°C with Sustainable Development Goals (SDGs). The assessment of interactions between mitigation measures and individual SDGs {5.4}.[6]

[6] Proxy indicators are: 1) Compound annual growth rate of primary energy (PE) to final energy (FE) conversion from 2020 to 2050; 2) % change in FE between 2010 and 2050; 3) Year-2050 carbon intensity of FE; 4) Year-2050 PE that is non-bio RE; 5) Year-2050 PE from biomass; 6) Year-2050 PE from nuclear; 7) Year-2050 $GtCO_2$ BECCS; 8) Year-2050 $GtCO_2$ Fossil-CCS; 9) Year-2050 share of non-livestock in food energy supply; 10) Cumulative CO_2 AFOLU over 2020-2100 period; 11) CH_4 and N_2O AFOLU emissions per unit of total food energy supply; 12) Change in global forest area between 2020 and 2050. Values of Indicators 2, 3, and 11 are inverse related with the deployment of the respective measures. The scenario values are displayed on a relative scale from zero to one where the lowest scenario is set to the origin and the values of the other indicators scaled so that the maximum is one.

4.6 Reducing climate vulnerability through adaptation is mostly synergistic with sustainable development, especially those associated with agriculture, health and ecosystems. Adaptation needs will be lower in a 1.5°C as compared to a 2°C warmer world, but adaptation limits are expected to be exceeded in multiple systems and regions in a 1.5°C warmer world {Chapter 3; 4.4.1, 4.4.3, 4.4.6, 4.5.1, 5.2.3, 5.3.2, 5.6.3}

- Adaptation needs will be lower in a 1.5°C as compared to a 2°C warmer world. Limits to adaptation and resulting losses to lives, livelihoods and infrastructure exist at every level of warming (*medium confidence*), with place-specific implications, for example for Small Islands Developing States. While transformational adaptation is necessary under current (~1°C) warming conditions, adaptation limits are expected to be exceeded in multiple systems and regions in a 1.5°C warmer world, putting large numbers of poor and vulnerable people, systems and regions at risk (*medium evidence)* {Chapter 3; 4.4.1, 4.4.3, 4.4.6, 4.5.1, 5.2.3, 5.6.3}

- Reducing climate vulnerability through adaptation is mostly synergistic with sustainable development in general, and the Sustainable Development Goals specifically *(high confidence)*. Some adaptation strategies result in trade-offs and make it more difficult to meet some Sustainable Development Goals *(high confidence)*. Transformative adaptation required to achieve sustainable development in a 1.5°C warmer world needs to address the root socio-economic and cultural causes of vulnerability (*high confidence*). {5.3.2}

4.7 There is a risk from adaptation to global warming of 1.5°C being unattainable without increased finance and the active involvement of the financial sector. Adaptation measures will require more investment than today, but less than for global warming of 2°C. Financial and technological support is needed to build capacity for effective responses and climate multi-level governance in many countries. {Chapter 3, 4.4.6, 4.5.1}

- While adaptation finance has increased, weakness in distribution and monitoring mechanisms undermine their potential impact. {Chapter 3, 4.4.6, 4.5.1}

- Adaptation to global warming of 1.5°C would be unattainable without the active involvement of the financial sector, including central and multilateral banks, as front-loading of investments compared to current actions is unavoidable. This requires significant institutional capacity building at multiple levels to handle both climate and transition risks in the mainstream financial sector in all countries. (*medium agreement, medium evidence*). {4.4.6}

4.8 Adaptation and mitigation measures relating to the design and implementation of sustainable climate smart agriculture, shifts to sustainable and healthy diets, reduced food waste, and sustainable and climate smart forest management are cost-effective. In rural areas, there are large potential synergies with the Sustainable Development Goals. {4.3.3, 4.4.1, 4.4.5, 4.5.2, 4.5.3, 5.4.1.2, 5.4.1.5, 5.4.3}

- Combining adaptation and mitigation options can increase cost effectiveness, but the potential to scale up remains a challenge, for example, for agroforestry, ecosystem-based adaptation,

efficient food production, afforestation and reforestation *(medium agreement)* (Box SPM 2). {4.3.3, 4.4.1, 4.5.2, 4.5.3}

- Sustainable and climate-smart land/agricultural management, the shift toward sustainable and healthy diets and reduction of food waste and climate-smart sustainable forest management provide cost-effective measures and in many cases, CO_2 removal. Their design and implementation that take into account local people's needs, biodiversity and other sustainable development concerns provide large synergies with Sustainable Development Goals particularly within rural areas of developing countries. However, climate-smart agriculture can be biased towards technological solutions and ignore (gender) inequalities (Figure SPM7) *(high confidence)*. {5.4.1.2, 5.4.1.5}

- There are policies that can shield the poor or redistribute the burden of mitigation trade-offs related to land use e.g. cash transfers, food subsidies and improvements in yields *(high confidence)*. (Figure SPM7) {4.4.5, 5.4.3, Figure 5.4.2}

4.9 Climate-resilient development pathways aim to simultaneously meet the Sustainable Development Goals, strive for low-carbon societies, and limit global warming to 1.5°C, within the frame of equity and well-being for all. The potential for successfully pursuing such pathways depends on a country's development status and on the capacities of communities, institutions, and organisations to adapt and to mitigate, and hence differs substantially between richer and poorer nations. {1.4.1, 2.4.3, 2.5.2, 2.5.3, 4.4.1, 4.4.5, 4.5.1, 4.4.6, Box 4.6, 5.3.1, 5.4.1, 5.5.1, 5.5.2, 5.5.3, 5.5.4, 5.6.2, 5.6.3, 5.6.4}

- Scenarios show that with policies that focus on sustainable development with shifts to more sustainable energy, material and food consumption patterns, and lower energy demand could be achieved together with strong growth in economic output until the end of the century *(medium to high confidence)*. (Figure SPM7) {2.4.3, 2.5.2, 2.5.3}

- The efficiency of integrated approaches between mitigation, adaptation and sustainable development approaches to deliver triple-wins depends on several enabling conditions *(medium evidence, high agreement)*. {4.4.1, 5.3.1, 5.4.1, 5.5.1, 5.5.2, 5.5.3, 5.5.4}

- Mitigation and adaptation policies each have the potential for profound implications on equity, especially if framed without considerations of the complex local-national to regional linkages and feedbacks in social-ecological systems. {1.4.1, 4.4.5}

- The impacts on equity of climate change depend upon the conditions under which limiting global warming to 1.5°C and adapting to 1.5°C can be achieved. There are three key inequalities related to equity impacts: in the contributions to the problem; in impacts and vulnerability, such that the worst impacts may fall on those that are least responsible for the problem, including future generations; and in the power to implement solutions and response strategies. {1.4.1}

- The potential for climate-resilient development pathways differs between richer and poorer nations and regions (*very high confidence*), given different levels of development as well as differential responsibilities and capacities to cut emissions, eradicate poverty, and reduce inequalities and vulnerabilities. {5.6.2, 5.6.3}

- Community-led and bottom-up approaches offer potentials for climate-resilient development pathways at scale. At level of individuals, communities, and groups, emphasis on well-being, social inclusion, equity, and human rights helps to overcome limitations in capacity *(medium evidence; high agreement).* {Box 4.6, 4.4.1, 5.6.2; 5.6.3}

- Participatory multi-level governance and iterative social learning constitute key aspects to enable transformative social change in a 1.5°C compatible development pathway. Yet, dominant pathways and entrenched power differentials continue to undermine the rights, values, and priorities of disadvantaged populations in decision making *(high confidence).* {4.4.1, 5.6.4}

- Very limited indicators and monitoring and evaluation systems currently exist that track multi-level progress toward equitable, fair, and socially desirable low-carbon futures (*high confidence*). {4.5.1, 5.6.4}

- Examples from around the world illustrate that 1.5°C-compatible, inclusive, prosperous and healthy societies are possible. At the same time, very few cities, regions, countries, businesses or communities are truly in line with 1.5°C. Increased ambition, connecting emission reduction options via interconnected value chains and multi-level governance, and enhanced capabilities are necessary (*medium agreement, medium evidence).* {Case studies in 4.4, 4.4.1, 4.4.2, 4.4.6}

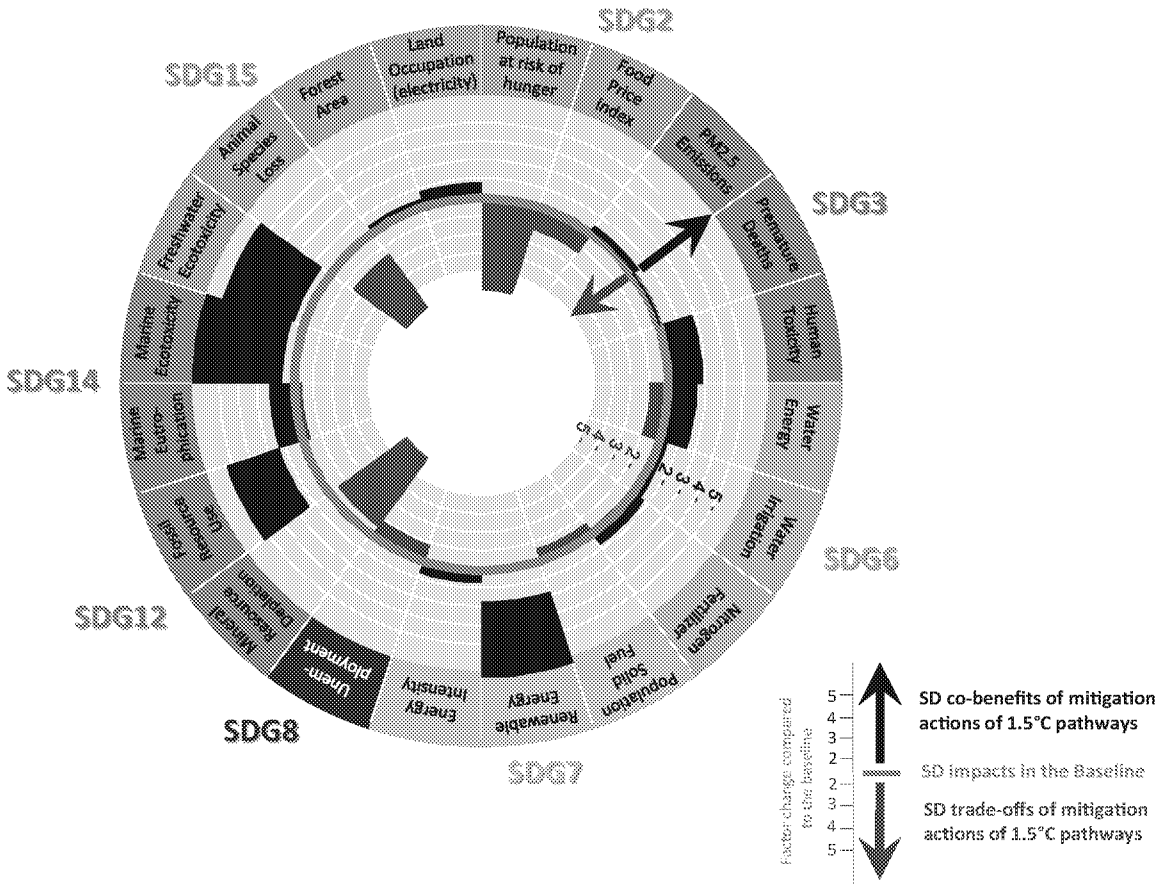


Figure SPM 6: Co-benefits (black) and risks for trade-offs (red) of mitigation consistent with limiting mean temperature to 1.5°C by 2100 assuming middle-of-the-road future socio-economic development. Co-benefits and trade-offs are measured in 2050 relative to middle-of-the-road baseline pathways without new mitigation policies (bold grey circle), and cover 21 sustainable development dimensions across seven Sustainable Development Goals (SDGs) (and selected sub-targets). Range denotes estimates across six different integrated assessment models, which were coupled to disciplinary models for the assessment of hunger, health, energy access, toxicity, and mineral resource implications of the pathways. Note that the realization of the side-effects will critically depend on local circumstances and implementation practice. Trade-offs across many SD dimensions can be eradicated through complementary/redistributional measures. Figure is not comprehensive and focuses on SD dimensions for which quantifications across models are available.

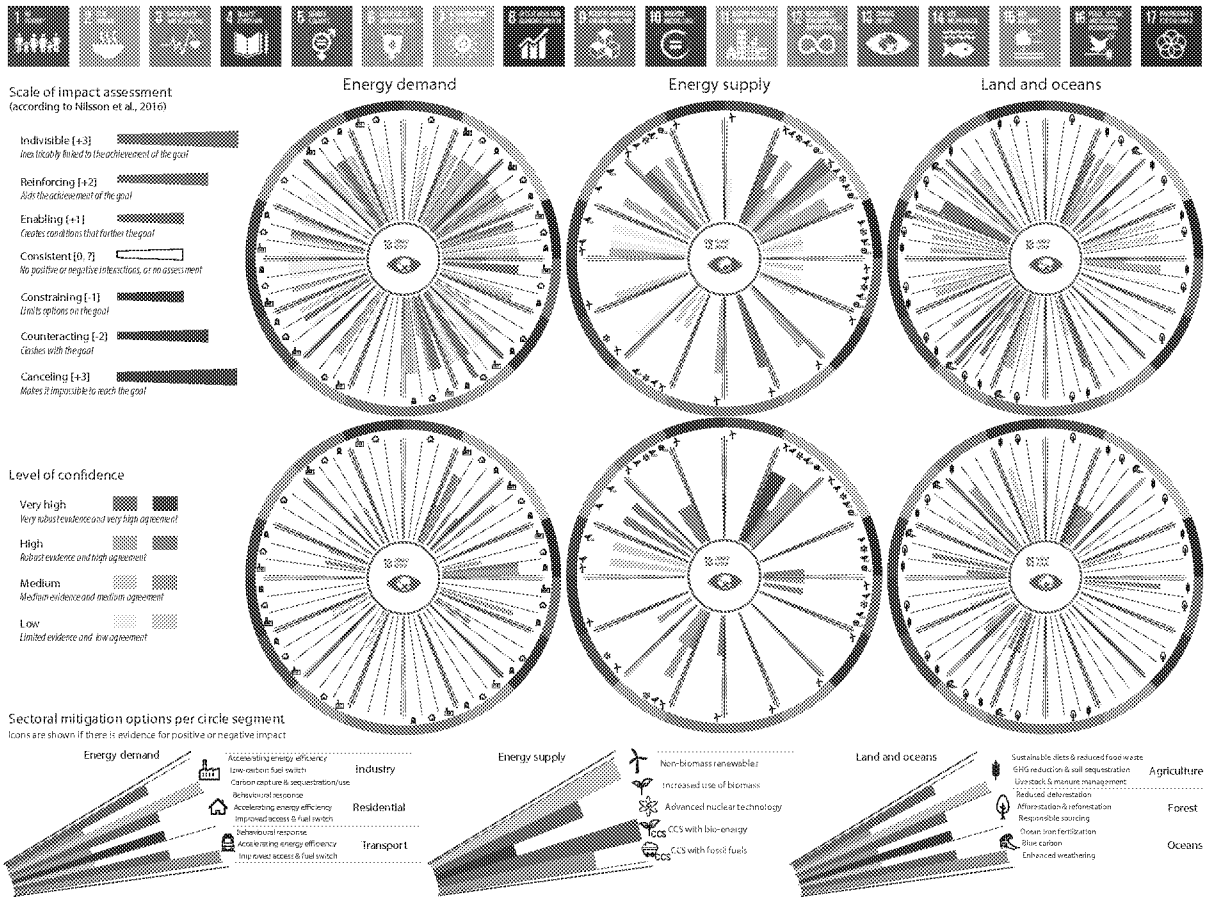


Figure SPM 7: Synergies and trade-offs between mitigation options and sustainable development goals. Top three wheels are representing synergies and bottom three wheels show trade-offs. Colours on the border of the wheels correspond to the Sustainble Development Goals (SDGs) listed above. Here SDG 13 climate action is at the centre because the figure shows if mitigation actions (climate action) in various sectors are taken then what do they interact with the 16 SDGs. Vertically, starting from the first left side, pairs of wheels correspond to synergies (Top) and trade-offs (Bottom) of three mitigation actions undertaken in each of the energy demand sectors (Industry, Residential and Transport sectors). Middle pair of wheels vertically shows the synergies (Top) and tradeoffs (Bottom) with SDGs of the five mitigation actions taken in the energy supply sector. Right most pair, shows synergies (top) and tradeoffs (bottom) with SDGs of three types of mitigation actions in each of the sectors Agriculure, Forestry and Oceans. Length of the coloured bars show the strength of the synergies or tradeoffs. Longer the bar higher is the strength. Shade of the color represent level of confidence based on evidence and agreement in the literature. Darker the shade higher is the confidence and lighter the shade confidence level is lower. White within wheels show no interaction between the corresponding mitigation action sand the SDG, grey within the wheels show knowledge gap. Bottom panel shows various mitigation actions in each sector and corresponding symbols.

Box SPM 2: Cities and global warming of 1.5°C

Box SPM 2.1 Rapid, systemic transitions in urban areas will be a critical element of an accelerated transition to a 1.5°C world. {1.1, 1.41, 4.3, 4.3.7, 5.4.1.4, Box 5.1}

- Such deep, structural changes can be enabled by a rapidly implemented, integrated mix of mitigation and adaptation measures, facilitated by local and regional governments, supported by national governments, and aligned with sustainable development. Both technological and social innovations in enabling technologies can contribute to 1.5°C pathways, including smart grids, energy storage technologies and general-purpose technologies, such as information and communication technologies and artificial intelligence. {4.3.7}

- Limiting global warming to 1.5°C is associated with an opportunity for innovative global, national and subnational governance, enhancing adaptation and mitigation within the framework of sustainable development, and linked with global scale trends including increased urbanization and decoupling of economic growth from greenhouse gas emissions. {1.1,1.4.1}

- The circular economy concept such as zero waste, decarbonisation and dematerialisation shows high synergies with sustainable development goals {Box 5.1, 5.4.1.4, 4.3}

Box SPM 2.2 Each additional level of global warming increases risks to urban areas, and future impacts will depend on vulnerabilities (location, infrastructure and levels of poverty) and adaptation capacities {3.2.1, 3.3, 3.3.2, 3.3.12, 3.4.8, Cross-Chapter Box 3.2, 4.3, 5.4.1.3, Box 5.1}

- An additional 0.5°C of warming increases risks to urban areas. For example, under a mid-range population growth scenario, more than 350 million more people would be exposed to heat stress by 2050 in mega-cities with 1.5°C of global warming. {3.2.1, 3.3, Cross-Chapter Box 3.2}

- Warming of 2°C poses greater risks to urban areas than warming of 1.5°C in most cases, often varying by vulnerability of location (coastal and non-coastal), infrastructure sectors (energy, water, transport), and by levels of poverty. {3.3.2, 3.3.12, 3.4.8}

- In 1.5°C pathways, all end-use sectors, such as the food (livestock), building, transport, and industry sector, require significant demand reductions by 2030, beyond those projected for 2°C pathways. {Box 5.1, 5.4.1.3, 4.3}

Box SPM 2.3 Combining adaptation and mitigation options can increase cost effectiveness, but the potential to scale up remains a challenge. {4.3.3; 4.3.4; 4.4.1; 4.5.2; 4.5.3}

- Examples include land-use planning, urban planning and urban design *(medium agreement)*; implementing building codes and standards to reduce energy use and manage risk *(high agreement)*. Sustainable water management (*high evidence, medium agreement*) and investing in green infrastructure (*medium evidence, high agreement*) to deliver sustainable water and environmental services and support urban agriculture are less cost effective but identified as important elements for fostering urban climate resilience. However, it is often challenging to combine governance, finance and social and policy support including alignment of the multiple objectives and timings, even if multiple benefits are achieved {4.3.3; 4.3.4; 4.4.1; 4.5.2; 4.5.3}

Message

From: Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]
Sent: 9/24/2018 7:40:08 PM
To: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
CC: Talley, Trigg [TalleyT@state.gov]; Alpert, Alice [AlpertA@state.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]; Gray, Stephen [sgray@usgs.gov]; Haxthausen, Eric M. (E3/GCC/PEL) [ehaxthausen@usaid.gov]
Subject: Re: IPCC call - C
Attachments: image001.png; image002.png

Hello all,

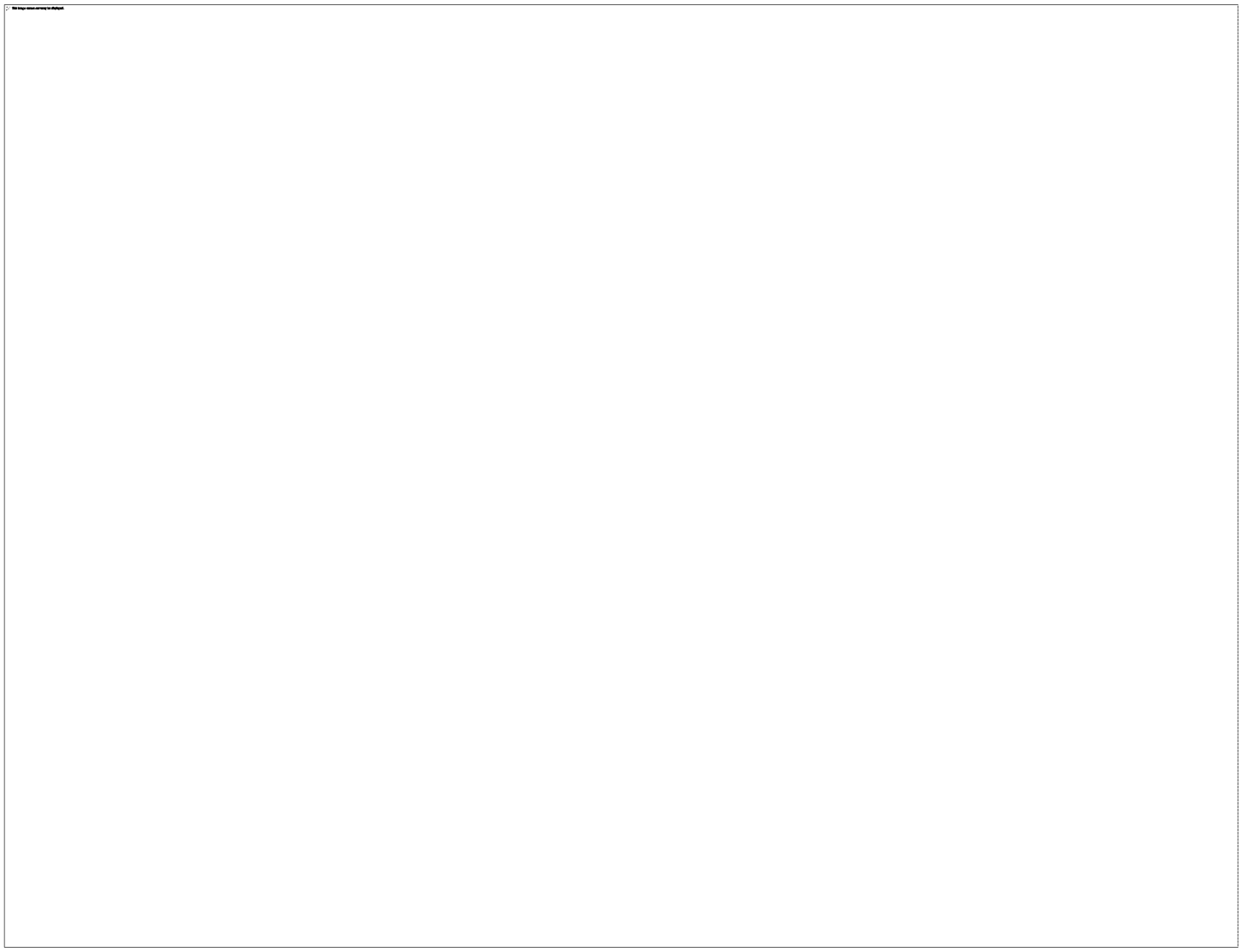
Three things:

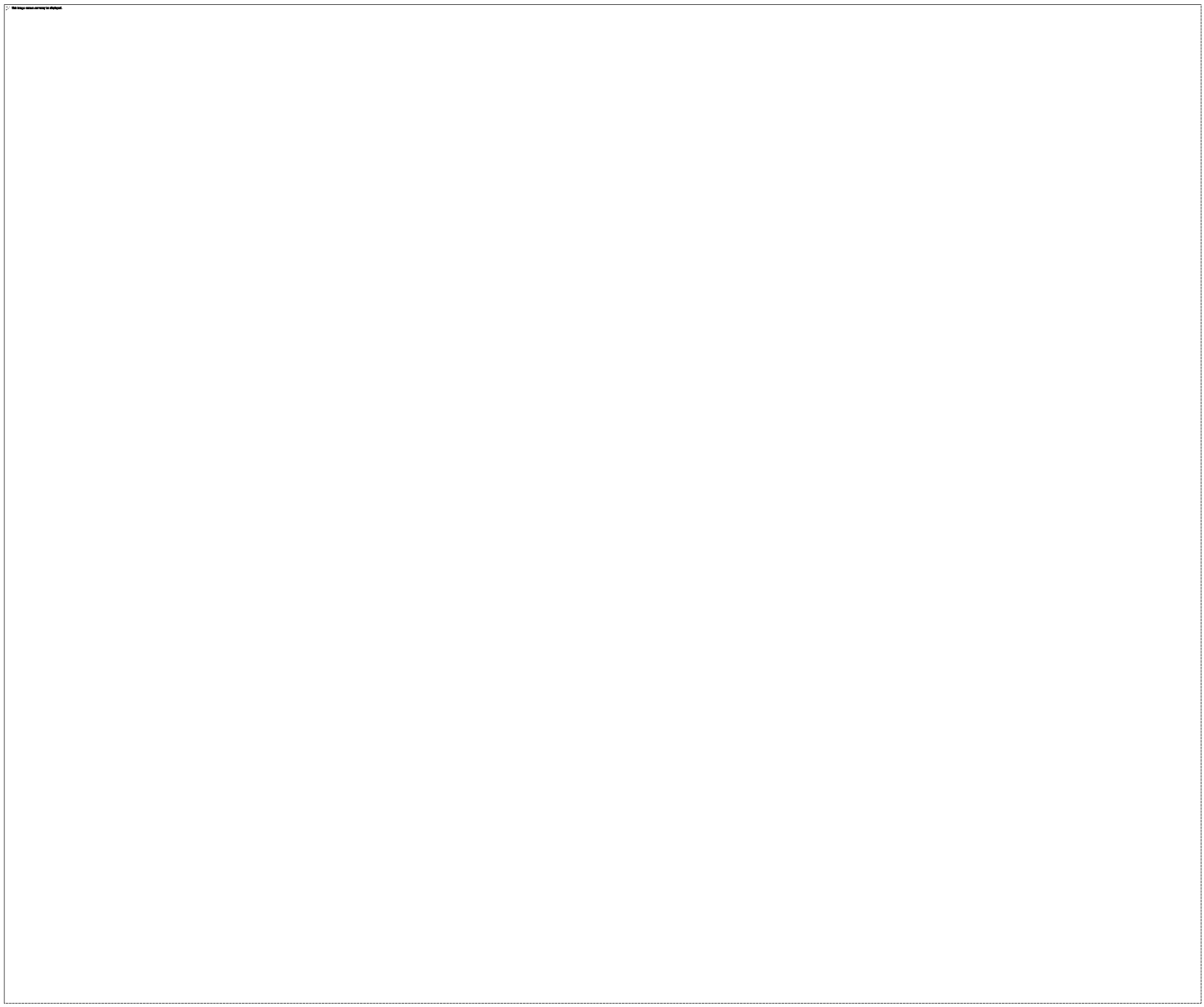
1) Allen circulated the same blogs on carbon budgets that I had in mind. I had emailed the author Glen Peters last week and he sent me the same links and confirmed he didn't have anything that delved deeper into why more recent literature tends to show larger C budgets associated with 1.5 and 2C compared to AR5 estimates.

2) We had talked about the importance in section B of the SPM to be more explicit about the implications of overshooting 1.5C. The only statement appears to be one that's somewhat buried in the middle of B2; it's the second sentence beginning "Temperature overshoot, if much higher...". I think this should be called out as its own stand-alone finding. This language is consistent with language in Chapter 3.

3) Regarding the burning embers SPM Figure 2, lower panel, Chapter 3 actually does a pretty good job explaining the evidence and justification for the different colors for warm water corals, Arctic systems, etc. This is in section 3.4.13 of Chapter 3. Our comments do call out the SDGs as being an awkward fit in SPM Figure 2. And even though the same version of this figure appears in Chapter 3, it's worth noting that the description for this particular ember is somewhat weak: 3.4.13 states "Based on limited analyses there is evidence and agreement that risks to sustainable development are considerably less at 1.5C that 2C (Section 5.2.2) including avoided impacts on poverty and food security. It is easier to achieve many of the Sustainable Development Goals (SDGs) at 1.5C, suggesting that a transition to a higher risk has not yet begin (sic) at this level."

On Mon, Sep 24, 2018 at 1:56 PM Fawcett, Allen <Fawcett.Allen@epa.gov> wrote:





https://www.carbonbrief.org/analysis-how-much-carbon-budget-is-left-to-limit-global-warming-to-1-5c

---

Allen A. Fawcett, Ph.D.

Chief, Climate Economics Branch

U.S. Environmental Protection Agency

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Cell: (202) 412-5116

From: Fawcett, Allen
Sent: Monday, September 24, 2018 1:48 PM
To: Talley, Trigg <TalleyT@state.gov>; Alpert, Alice <AlpertA@state.gov>; Akhtar, Farhan H <AkhtarFH@state.gov>
Cc: 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>; 'Gray, Stephen' <sgray@usgs.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>
Subject: RE: IPCC call - C

Here's the best explanation I could find of the climate budget issues we discussed on the call:

https://www.carbonbrief.org/analysis-how-much-carbon-budget-is-left-to-limit-global-warming-to-1-5c

And here's another useful post:

https://www.cicero.oslo.no/no/posts/klima/beyond-carbon-budgets

And finally Glen Peters 'Beyond carbon budgets' paper:

https://www.nature.com/articles/s41561-018-0142-4.epdf?shared_access_token=3wibX529e9_t6lr7L9qMrtRgN0jAjWel9jnR3ZoTv0N_KhMjhNgCl_1iWCi_f50OWLRRUrwH4niafQnrXR7x1FuczoM00Ss-MJhk8YHoyvULoRhxE9iWeYDr3r4Xl0j_oVMJB4iuzNl94vAQ7OF7_sxVlfbJay6DOQz-A-QvnZU%3D

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-----Original Appointment-----
From: Seen, Emily J [mailto:SeenEJ@state.gov]
Sent: Tuesday, September 18, 2018 5:39 PM
To: Seen, Emily J; Talley, Trigg; Alpert, Alice; Akhtar, Farhan H
Cc: 'Benjamin DeAngelo - NOAA Federal'; 'Gray, Stephen'; Haxthausen, Eric M. (E3/GCC/PEL); Fawcett, Allen
Subject: IPCC call - C
When: Monday, September 24, 2018 12:30 PM-1:30 PM (UTC-05:00) Eastern Time (US & Canada).
Where: 877-336-1839; 8100701#

--

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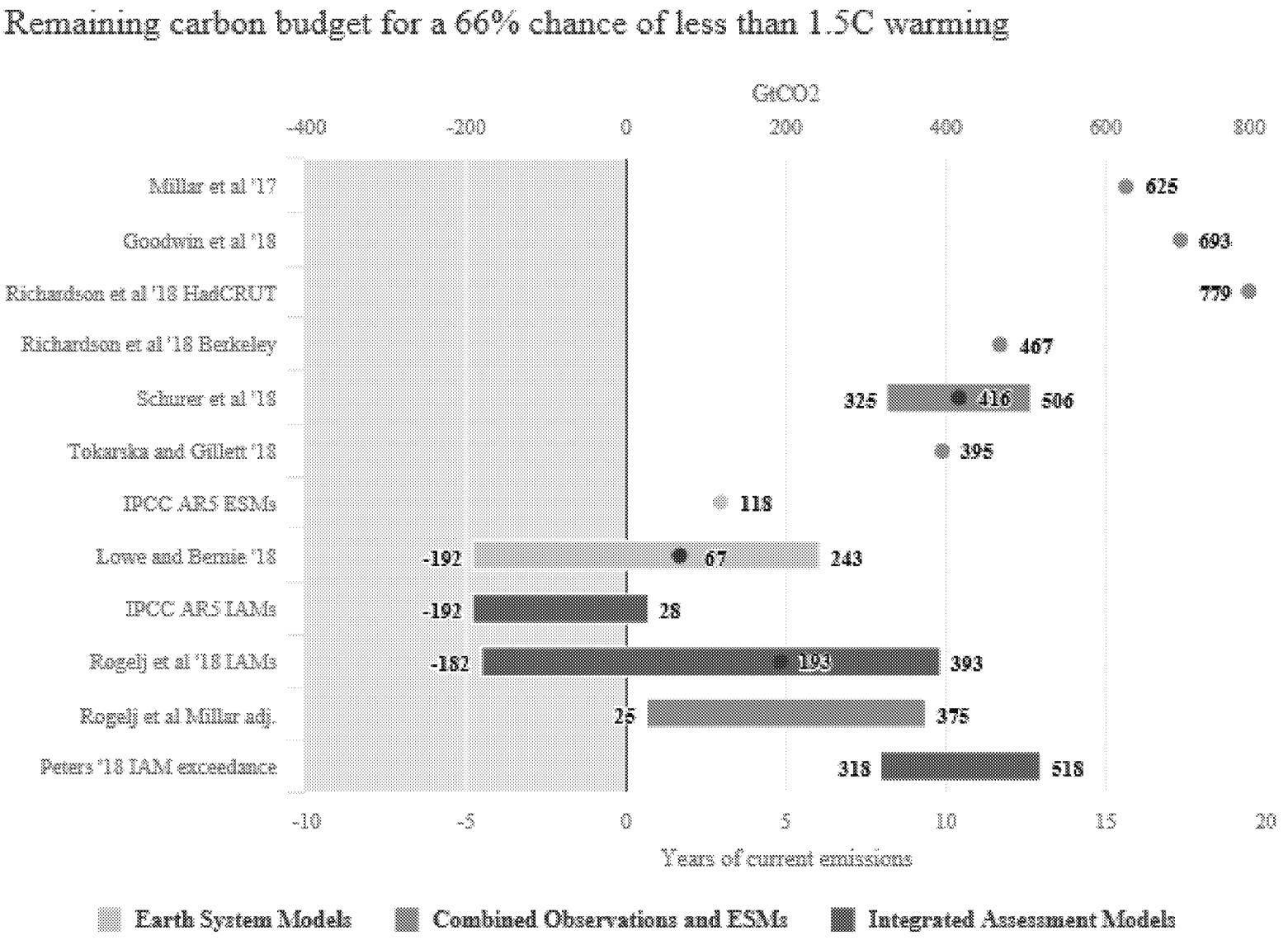

Remaining carbon budgets in gigatonnes CO2 (GtCO2) from various studies that limit warming to a 66% chance of staying below 1.5C (see links at end of article), as well as equivalent years of current emissions using data from the Global Carbon Project. Ranges reflect reported budget uncertainties, while points show best-estimates. All studies have been normalised based on observed emissions to show the remaining budget as of January 2018. Integrated assessment models limit warming to well below 1.5C warming in the year 2100, while other approaches avoid any exceedance within the next century. Chart by Carbon Brief using Highcharts.

Message

From: MIT Joint Program [globalchange@mit.edu]
Sent: 11/8/2018 10:02:32 PM
To: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: Global Changes: Fall 2018 Newsletter

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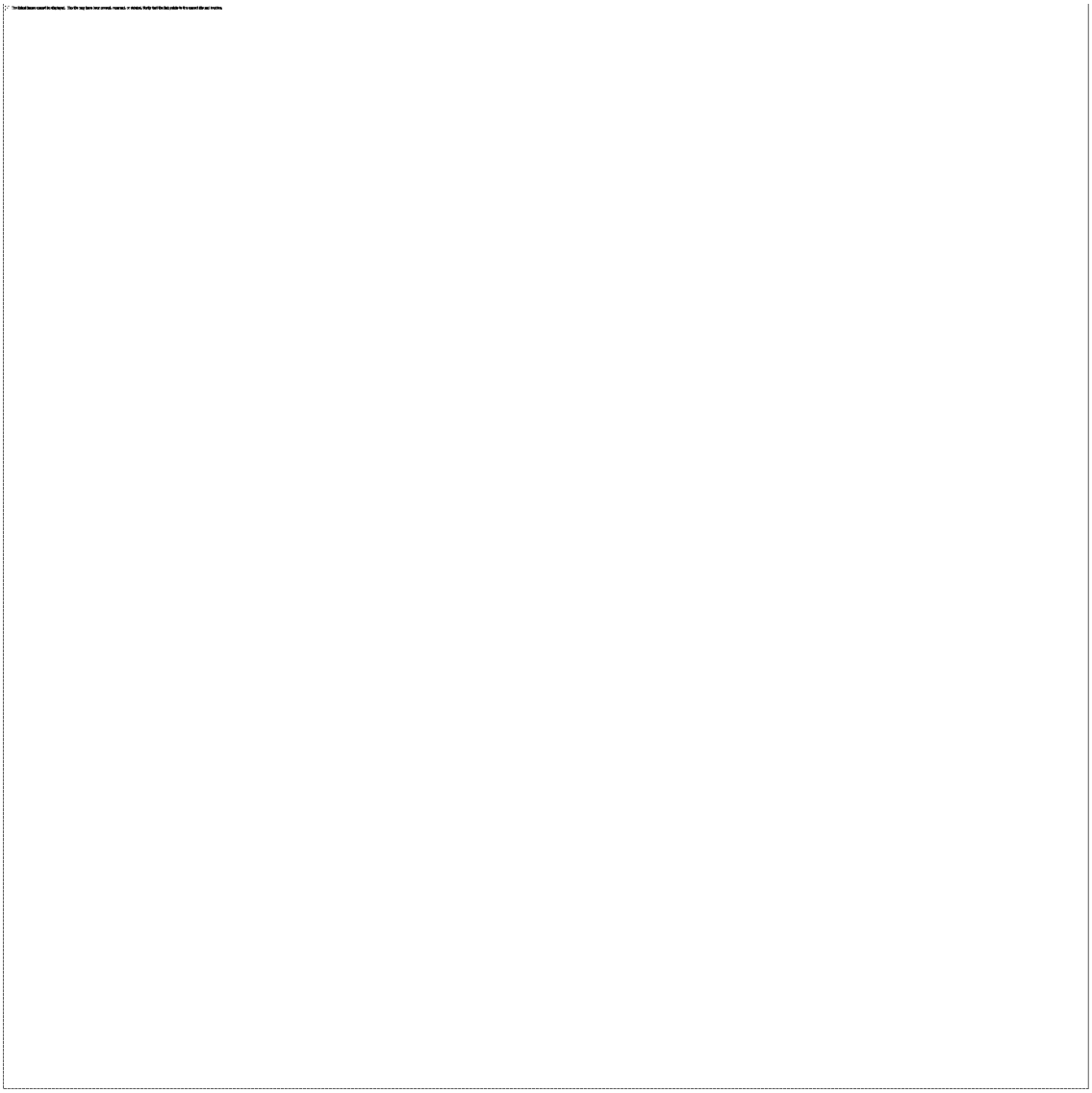


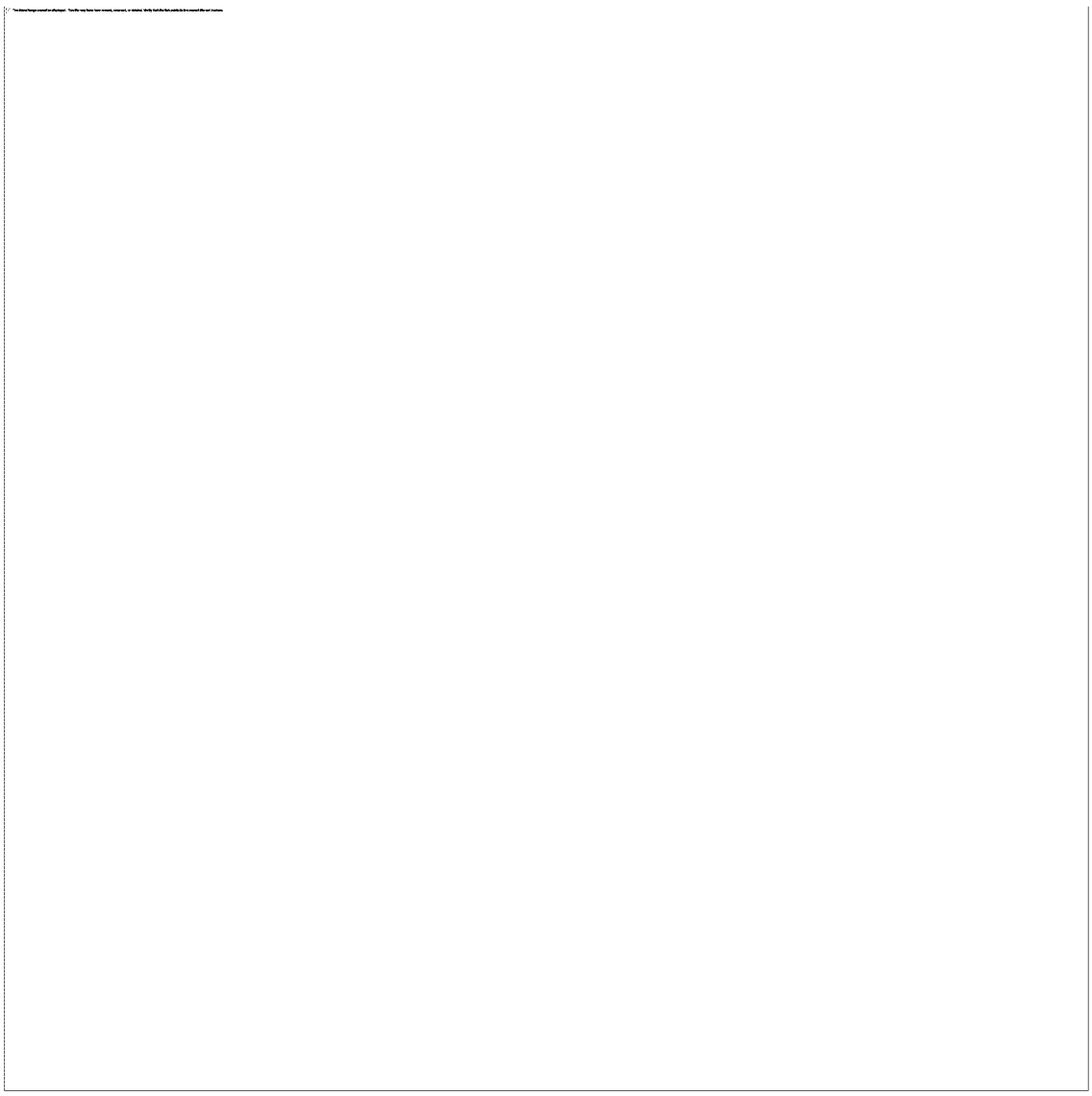
FALL 2018

CONTACT: Mark Dwortzan (dwortzan@mit.edu)

Global Changes

Fall 2018 Newsletter

Insights, news, projects, publications and other developments at the MIT Joint Program



We are pleased to present the Fall 2018 *Global Changes* newsletter, a 10-page digest featuring:

- the latest insights from our co-directors on global changes and their implications (in this issue: **Our take on the IPCC Special Report on Global Warming of 1.5°C)**
- clickable summaries of news releases and media coverage over the past six months
- new publications and professional milestones over the past six months

To keep you updated on Joint Program news releases and media coverage in between issues of *Global Changes,* we will continue to send you our e-newsletter, *Global Snapshot*.

Please note that we are no longer automatically distributing paper copies of Global Changes. To receive a print version of the newsletter--or provide feedback on its contents and format--please contact us at jp-comm@mit.edu.

The MIT Joint Program on the Science and Policy of Global Change is MIT's response to the research, analysis and communication challenges of global environmental change. We combine scientific research with policy analysis to provide an independent, integrative assessment of the impacts of global change and how best to respond. At the heart of the Programâ€™s work lies the MIT Integrated Global System Modeling framework, a linked set of computer models that analyzes interactions among human and Earth systems.

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Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/24/2018 4:28:52 PM
To: ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: IPCC - (missing) points on EE & impact on cost; geographic distribution of cost/impact tradeoffs
Attachments: Hof et al - Global and regional abatement costs of NDCs and enhanced action.pdf; Pretis et al. (2018) Phil Transactions A -.pdf

Following up on discussion just now:

1) Point on key role of energy efficiency and reduced demand:

The paper I mentioned is Rogelj, J. et al. Energy system transformations for limiting end-of-century warming to below 1.5 °C. Nat. Clim. Change 5, 519–527 (2015). (Available at https://www.nature.com/articles/nclimate2572)

If you look at Figure 4 in this paper and the preceding text on energy efficiency, it is apparent that the low energy demand scenarios (the triangles) are significantly less costly than the high energy demand scenarios (the diamonds).

This paper is cited in Chapter 1 (1.4.3) and Chapter 2 (2.4.3), but the point is not made as directly as might be desirable.

2) Point on geographic distribution of burden/impact of 1.5 vs 2 degrees:

This can be deduced from two separate papers, both of which are cited in the FGD. However, the synthetic point about the tradeoffs between cost of mitigation and incremental impact is only weakly brought into the FGD, mainly in Chapter 3.5.3

- Pretis, F., M. Schwarz, K. Tang, K. Haustein, and M.R. Allen, 2018: Uncertain impacts on economic growth when stabilizing global temperatures at 1.5°C or 2°C warming. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376(2119), 20160460, doi:10.1098/rsta.
    - Pretis et al. (2018) (attached) find that the economic impacts of going from 1.5 to 2 degrees are statistically distinguishable from zero (to a 95% level) only for a set of 19 countries in the tropics. (See Figures 4 and 5.) This paper is cited in Chapters 3 (3.5.3, where it is misspelled as Petris et al.) and 5 (5.2.1, 5.2.2) of the FGD.

- Hof, A.F. et al., 2017: Global and regional abatement costs of Nationally Determined Contributions (NDCs) and of enhanced action to levels well below 2 °C and 1.5 °C. Environmental Science {&} Policy, 71, 30-40, doi:10.1016/j.envsci.2017.02.008.
    - Section 4 of the paper and Figures 4 and 5 show that the abatement (mitigation) costs of the increment from 1.5 to 2 degrees fall disproportionately on non-OECD countries: "Overall, the potential for additional emission reduction is larger in non-OECD 90 countries, and therefore the group of non-OECD90 countries has the largest increase in domestic abatement costs in the 2 °C

and 1.5 °C scenarios (Fig. 4). This is again under the assumption of cost-optimal emission reductions, and without financial transfers or effort-sharing combined with trading of emission credits, both of which would help to alleviate the burden on non-OECD countries."

- Hof et al (2017) is cited in 2.5.1, 2.5.2.1, and Cross-chapter Box 11, but on different topics.

****

Excerpt from FGD 3.5.3, which addresses this issue, but citing papers that don't properly quantify the mitigation costs (Burke et al (2018) does so as a sort of afterthought, and does so erroneously and misleadingly.):

A critical issue for developing countries in particular is that advantages in some sectors are projected to be offset by the increasing mitigation costs (Rogelj et al., 2013; Burke et al., 2018)– with food production being a key factor. That is, although restraining the global temperature increase to 2°C is projected to reduce crop losses under climate change, relative to higher levels of warming, the associated mitigation costs may increase the risk of hunger in lowincome
countries (low confidence) (Hasegawa et al., 2016). It is likely that the even more stringent mitigation measures required to restrict global warming to 1.5°C (Rogelj et al., 2013) will further increase these mitigation costs and impacts.

Although warming is projected to be the highest in the Northern Hemisphere under 1.5°C or 2°C of global warming, regions in the tropics and Southern Hemisphere subtropics that are projected to experience the largest impacts on economic growth (limited evidence, medium confidence) (Gallup et al., 1999; Burke et al., 2018; Petris et al., 2018). Despite the uncertainties associated with climate change projections and econometrics (e.g., Burke et al., 2016), it is more likely than not that there will be large differences in economic growth under 1.5°C and 2°C of global warming for developing versus developed countries (Burke et al., 2018; Petris et al., 2018). Statistically significant reductions in Gross Domestic Product (GDP) per capita growth are projected across much of the African continent, southeast Asia, India, Brazil and Mexico
(limited evidence, medium confidence). Countries in the western parts of tropical Africa are projected to benefit most from restricting global warming to 1.5°C as opposed to 2°C, in terms of future economic growth (Petris et al., 2018). An important reason why developed countries in the tropics and subtropics are to benefit substantially from restricting global warming to 1.5°C, relates to present-day temperatures in these regions being above the threshold thought to be optimal for econonomic production (Burke et al., 2015b, 2018).

3) As we will discuss later today, the SPM and underlying report don't really tackle the question of total mitigation costs. (Allen, correct me if I am mistaken about this, but I've looked for it pretty carefully.) This is a significant related oversight of the underlying report.

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Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/24/2018 1:43:49 PM
To: Talley, Trigg [talleyt@state.gov]; ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]; sgray@usgs.gov
CC: David Dokken (Contractor) [ddokken@usgcrp.gov]; Seen, Emily J [SeenEJ@state.gov]
Subject: Fwd: IPCC 1.5 SPM commentary

Flagging for your awareness a Guardian piece yesterday on the report alleging that the SPM has been "watered down". I don't recall actually seeing these points - perhaps they were in the SPM first draft?

https://www.theguardian.com/science/2018/sep/23/scientists-changing-global-warming-report-please-polluters

---------- Forwarded message ---------
From: **Noel Gurwick** <ngurwick@usaid.gov>
Date: Mon, Sep 24, 2018 at 9:26 AM
Subject: IPCC 1.5 SPM commentary
To: Eric Haxthausen <ehaxthausen@usaid.gov>, Collin Green <cgreen@usaid.gov>, Geoffrey Blate <gblate@usaid.gov>, Juliann Aukema <jaukema@usaid.gov>, Katherine Faulhaber <kfaulhaber@usaid.gov>, Kathryn Stratos <kstratos@usaid.gov>, Lexine Hansen <lhansen@usaid.gov>, Matthew Ogonowski <mogonowski@usaid.gov>, ngurwick@usaid.gov <ngurwick@usaid.gov>, Peter Epanchin <pepanchin@usaid.gov>

Climate study 'pulls punches' to keep polluters on board

The Observer reports on accusations that key messages from the upcoming Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5C have been "watered down" to make them more "palatable" to countries that are reluctant to cut their fossil fuel emissions. Bob Ward, policy director at the Grantham Research Institute on Climate Change and the Environment, is a reviewer of the report who has seen several drafts of the report and its accompanying summary for policymakers. He told the Observer: "Downplaying the worst impacts of climate change has led the scientific authors to omit crucial information from the summary for policymakers." According to Ward, edits have been made to the summary for policymakers – the document that will act as a guideline for politicians – to omit "any mention that temperature rises of above 1.5C could lead to increased migrations and conflict". Other edits include the removal of "warnings about the dangers that 1.5-2C temperature rises could trigger irreversible loss of the Greenland ice sheet and raise sea levels by 1-2 metres over the next two centuries," the Observer reports. An IPCC spokesperson told the Observer that member governments would work to ensure the summary for policymakers was consistent with the findings in the main report. "Any text in the summary for policymakers ... is based on the assessment in the main report. Even if it is removed from the summary for policymakers, the finding it is based on remains in the main report." On Twitter, report author Prof Piers Forster said he "completely disagreed" with the accusations. Robin McKie, The Observer

--
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U.S. approach to Special Report on 1.5C of Warming, Summary for Policy Makers

A. Understanding global warming of 1.5°C

A1. Human-induced global warming reached approximately 1±0.2°C (*likely* range) above pre-industrial levels in 2017 and is currently increasing at 0.2±0.1°C per decade (*high confidence*).

- The use of "human-induced" here in combination with use of a single year (2017) implies that 100% of observed warming since pre-industrial has been human induced.

A2. Past emissions alone are unlikely to raise GMST to 1.5°C above pre-industrial levels, but do commit to further changes such as sea-level rise and associated impacts (high confidence). If emissions continue at their present rate, human-induced warming will exceed 1.5°C by around 2040 high confidence).

- Add ± 0.5°C uncertainty whenever 1.5°C warming is mentioned.

A3. Risks for natural and human systems are lower for global warming of 1.5°C than at 2°C depending on geographic location, levels of development and vulnerability, and on the choices of adaptation and mitigation options (*high confidence*)

- The statement that "risks for natural and human systems are lower" should be qualified to say that "in aggregate" the risks are lower, as for some systems and in some scenarios, the risks could be higher in a 1.5°C non-overshoot scenario.
- The formulation "depending on..." could imply that risks at 1.5C may not be lower, in aggregate, than at 2C. We therefore have specific edits. SEE A3 SHEET.

A4. Sustainable development, poverty eradication and implications for ethics and equity will be will be key considerations in mitigation efforts to limit global warming to 1.5°C and by efforts to adapt to 1.5°C global warming {*high confidence*}.

- This subsection should be moved to Section D and given lower priority in the SPM. A4, A4.2 and A4.3 present general and theoretical points that are not specific to 1.5°C and that are less informative to policy makers than the specific conclusions of the report about warming of 1.5°C.
- The statement about the poor and vulnerable does not track well with the underlying report as written; it should be revised for greater accuracy and precision. Chapter 3 reveals that inequality of outcomes is a much more significant issue at warming greater than 1.5 degrees than at 1.5°C.

- No level of impact could be considered proportionate. While there are inequities in the underlying vulnerability and resilience of some groups, everyone will be impacted by climate change.
- The Sstatement implies that benefits and adverse impacts will come from mitigation options alone, while adaptation options will also affect the poor and vulnerable and could have both negative and positive outcomes depending on the population.
- The Climate Resilient Development Pathways referred to here are a theoretical construct based upon a circular argument. The authors describe the climate resilient development goal and then how it may be achieved without first examining whether it can be achieved. For example, the

pathways include actions and changes by the global community of nations that are far faster than there is any indication would be possible.

A5. There is no simple answer to the question of whether it is feasible to limit warming to 1.5°C and to adapt to the consequences because feasibility has multiple dimensions that need to be considered simultaneously and systematically.

- The originally drafted statement is completely unsatisfactory for the SPM, as it fails to convey useful information. At best, the abstract discussion of "feasibility" presented here is more appropriate for the definitions section of the SPM than a full paragraph in Section A.
- In general, the SPM narrative, beginning with Section A, fails to communicate the scale of the global technological and economic challenge to meet a 1.5°C objective. Rather than the statement in A5, it would be more useful to offer a summary of the type of transition that would be needed to limit warming to 1.5°C.

~~"Feasibility," as it is used in this report, is not strictly a technical or geophysical question of whether a strategy can be accomplished, but is a more nuanced question of whether the consequences of accomplishing a strategy might be judged by society to be unacceptable because of factors such as cost, environmental damage, the need for cultural or social accommodation or transformation, etc. The statement does not address the full definition of feasibility.~~

Figure 1

- Figure elements are not directly from the underlying cited chapters. A legend or caption must clarify the data source and whether the panels in Figure SPM-1 represent a conceptual or illustrative representation of the points depicted.

B. Projected climatic changes, their potential impacts and associated risks at 1.5°C global Warming

B1. For some extremes, ~~T~~there are estimated to be ~~substantial~~ increases ~~in extremes~~ between the present-day and a global warming of 1.5°C, and between 1.5°C and 2°C, namely~~including~~ hot extremes in all inhabited regions (*high confidence*), heavy precipitation events in most regions (*high medium? confidence*), and ~~extreme~~ droughts in some regions (*medium confidence*).

- The use of the word "substantial" is undefined when describing the difference in impacts at 1.5°C versus 2°C of warming.
- Define 'extremes' earlier. It should be noted that globally there are no measureable increases in a wide categories of extreme events. Insert "some" before "extremes."
-

B2. On land, net risks of climate-induced impacts on biodiversity and ecosystems, including species loss and extinction, are ~~substantially~~ less at 1.5°C global warming than at 2°C. ~~Limiting global warming to 1.5°C has large benefits for terrestrial and wetland ecosystems and for the preservation of their services (*high confidence*).~~ Temperature overshoot, if much

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Commented [BD1]: This should not be our talking point here. The main talking point is that this originally drafted statement is completely unsatisfactory for the SPM, as it completely fails to convey useful information. We have specific comments in our spreadsheet that point to more useful language that appears later in the SPM itself (such as C3). In scanning other country comments on this statement, no one is happy with it; everyone thinks it's way too vague.

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higher than 1.5°C (e.g. close to 2°C), could have irreversible impacts on some species, ecosystems and their ecological functions and services to humans, even if global warming eventually stabilizes at 1.5°C by 2100 (*high confidence*).

- This section should note the relative importance of the warming differential between 1.5 and 2°C versus other environmental and human-caused factors that influence biodiversity.
- The statement that losses at 2°C are more "substantial" could be interpreted as 10% more species loss in the minds of some readers and 75% in others. Statement B2.1 is based on a limited number of studies with a wide (1-18%) confidence interval. It is misleading to perform an operation on the mean value (i.e., comparing to proportion of insect species experiencing range loss at 2°C) without stating the propagated uncertainty.

B3. Due to projected differences in ocean temperature, acidification and oxygen levels, limiting warming to 1.5°C compared to 2°C would substantially reduce risks to marine biodiversity, ecosystems and their ecological functions and services to humans, ~~in ocean and coastal areas, especially~~ Arctic sea-ice ecosystems and warm water coral reefs are particularly at risk if warming exceeds 1.5C. [CONFIDENCE?]

- The statements should only include ocean ecosystems experiencing large-scale changes with identifiable thresholds between 1.5°C and 2°C. For example while increasing ocean acidification will have adverse impacts on many marine organisms, there is a lack of evidence in the underlying text that specific thresholds will be reached between 1.5°C and 2°C scenarios. The impacts at both 1.5°C and 2°C should be quantified, e.g. with virtually all warm water coral reefs damaged at 1.5C, what additional impact will there be at 2°C?

B4. By 2100, sea level rise would be around Xm above [pre-industrial/present-day levels] ~~0.1m lower~~ with 1.5°C global warming and about 0.1m lower compared to 2°C (*medium confidence*). Increased saltwater intrusions, flooding, and damage to infrastructure associated with increased sea level are especially harmful for vulnerable environments such as small islands, low-lying coasts, and deltas (*high confidence*)

- The statement needs to provide an absolute value, with uncertainty, of projected sea-level rise, not only the differential rise. Given that sea level rise in 2100 depends on whether there is 1.5C overshoot, the pathway and assumptions should be stated.
- The second sentence does not specifically address the consequences of 1.5°C of warming. It should be revised accordingly or deleted.

B5. Net negative ~~I~~impacts on health, livelihoods, food and water supply, human security, infrastructure~~, and the underlying potential for economic growth will~~ are projected to increase with 1.5°C of warming compared to today, and even more with 2°C warming compared to 1.5°C. [confidence statement?]

- The reference to the underlying potential for economic growth is not well supported in the underlying report, which provides a much more nuanced assessment, suggesting it is limited to a small set of countries. Moreover, the claim does not consider the critical issue of the mitigation costs of holding warming below 1.5°C. This reference should be deleted; at best, there is low confidence in such a claim.

- Several points in the sub-paragraphs are not supported in the underlying report. These include references to the urban heat island effect in B5.2, the claim relating to water scarcity in B5.4, and several aspects of the discussion of economic impacts in B5.5.
- We would recommend that B5.6 be reworded in plainer language rather than making such heavy reference to the RFCs. Also, the characterization of the implications of holding warming to 1.5°C on RFC5 is somewhat overstated and should be more carefully qualified or delimited to align with the underlying report text in Chapter 3.
- ~~As written, the statements are not unique to 1.5°C.~~
- ~~The sub-statements should include the importance of socio-economic drivers which are discussed and well-cited in the underlying text.~~

Commented [EH2]: Not sure these are our key points.

- The final point in the list ("the underlying potential for ...") is overly qualified compared with others. It should include information on whether the projected impacts on economic growth include the cost of mitigation measures required to reach 1.5 and 2°C scenarios; if not, this omission should be clarified. If nothing quantitative can be said, it should not be elevated to the SPM.

B6. Limits to adaptation and associated losses exist at every level of global warming (*medium confidence*) with site-specific implications for vulnerable regions and populations. Further adaptation is required within the assessed sectors of energy, land and ecosystems, urban, industrial, and transport systems, and within cross-cutting sectors such as disaster risk management, health and education; adaptation needs will be lower at global of 1.5°C, compared to 2°C.

- This section should potentially be removed. Otherwise~~First~~, the statement should include the underlying report's note that scant literature exists on adaptation needs or options at 1.5°C, whether there are limits to these adaptation options, and the degree to which transformational approaches can go beyond surpass the limits of other approaches. Specifically, the finding that adaptation needs would be lessened at 1.5°C of warming may be justified from expert judgement, but there is limited evidence ~~that policymakers target adaptation approaches to specific levels of warming~~. The section should focus on risks within a particular sector/region/category where there is sufficient evidence to establish a credible analysis of what limiting warming to 1.5 °C would mean for the development of adaptation needs and capacity.

Commented [BD3]: Don't know what this means.

- Much of this section is outside of the scope of the title of Section B ("Projected climatic changes, their potential impacts and associated risks at 1.5°C global warming"). The main paragraph B6 and the first subsidiary paragraph B6.1 should be revised to provide a general framing of the degree to which adaptation could mitigate impacts, in alignment with the topic of Section B.
- The adaptation discussion in paragraphs B6.2 - B6.4 is out of place with the focus of SPM section B ("Projected climatic changes, their potential impacts and associated risks at 1.5°C global warming"). These paragraphs should be removed or revised and moved to Section C or D, where they would fit with the discussion of systems transitions.
    - Paragraph B6.2, if retained, should be moved to Section C, and revised to include the underlying report's observation that inadequate literature exists to undertake a spatially differentiated assessment of adaptation to a 1.5°C world.

- Paragraph B6.3 does not reflect the underlying report. If retained, it should be moved to Section C and substantially revised to present the conclusions of the underlying report in a way that will be understandable to policymakers. For example, it would be helpful to distinguish strategies that apply to agricultural systems from those that apply to natural ecosystems.
- Paragraph B6.4 is not specific to 1.5°C and does not accurately reflect the underlying report. If retained, it should be moved to Section C or D and should be revised to accurately reflect the underlying report

Figure 2

- The evidence base for the expert judgement of the authors should be shown in the figure. The broad descriptions of impacts, such as "global aggregate impacts" and "distribution of impacts," provide little useful information, and the inclusion of "Ability to achieve SDGs" stands out as a contradictory finding to the underlying report where the multiple dimensionality of the interactions between warming and sustainable development is highlighted. The other impacts listed are fairly specific and amenable to quantification and offer some tangible information, though more information should be provided linking the basis for these findings to the underlying report.

C. Emission pathways and system transitions consistent with 1.5°C global warming

C1. All 1.5°C-consistent pathways imply rapid reductions in net global anthropogenic CO_2 emissions to reach net-zero around mid-century, together with rapid reductions in other anthropogenic emissions, particularly methane. Greater emissions reductions by 2030 lead to a higher chance of limiting global warming to 1.5°C without, or with only limited overshoot (zero to 0.2°C).

- The SPM has chosen findings that provide a more optimistic picture than warranted. Given the many uncertainty factors (climate sensitivity, role of non-CO2 forcers, overshoot/no overshoot, permafrost feedbacks, and uncertainties about warming estimated to date), the text should be revised to clearly communicate the total ranges of the remaining carbon budget estimates.
- All the scenarios highlighted in the SPM involve cutting global emissions by at least half by 2030. The message that outside of rapid emissions reductions in the next few years, only a very narrow path remains to achieve 1.5°C does not come across strongly enough in this report.

Commented [BD4]: This is primarily relevant for C1.2 thru C1.4.

C2. 1.5°C-consistent pathways can have different levels of carbon dioxide removal (CDR). Some limit global warming to 1.5°C without relying on bioenergy with carbon capture and storage (BECCS). Behaviour change, demand-side measures and emission reductions in the short term can limit the dependence on CDR (*high confidence*).

- The SPM obscures the key point that *all* modeled pathways to 1.5°C deploy CDR to some degree. The statement should quantify how much CDR would be needed with emphasis on the minimum. It should also state how quickly CDR would need to be deployed in order to maintain a realistic chance of achieving 1.5°C. As an alternative, strongly recommend condensing the key points in Chapter 2 Executive Summary.

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- The feasibility of CDR measures relies on much more than just how they impact sustainable development. It also depends ~~also on~~ largely on costs, environment and social co-benefits, and permanence.
-

C3. Limiting global warming to 1.5°C would require rapid and far-reaching systems transitions occurring during the coming one to two decades, in energy, land, urban, and industrial systems.

- The statement does not express the significant trade-offs in land use and the potentially highly transformative nature of land-use change as part of mitigation strategies that involve significant afforestation/reforestation and/or deployment of BECCS.
- The role of nuclear energy is absent in the SPM text and does not accurately reflect the degree to which scenarios rely on it. For example, nuclear energy supply is projected to increase through at least mid-century.
- The subbullet stating "There is no documented historic precedent for the scale [of energy, land, urban and industrial system changes] found in 1.5°C-consistent pathways" should be moved to the main finding. The issue of stranded assets should be included.

Figure 3

- Scenario pathways are not referenced in the text and not supported by literature references.

Figure 4

- The figure is too complicated to understand easily, and once studied carefully, presents little helpful information. It remains unclear how to interpret a relationship value of +3 versus +2, etc. Many interactions are presented with both trade-offs and synergies, leaving the reader unable to interpret the underlying message. To what extent is the scale of deployment reflected? Moreover, all sectors and aspects of sustainable development are presented as equal, when clearly some clusters may have more weight than others. The figure should be removed.

D. Strengthening the global response in the context of sustainable development and efforts to eradicate poverty

D1. Fulfilling the current pledges under the Paris Agreement (known as Nationally-Determined Contributions or NDCs) will still result in global warming of more than 1.5°C, with associated risks and adaptation challenges. Emissions reductions and action in addition to current NDCs lead to lower overshoot and lower transitional challenges after 2030 and can contribute to the achievement of the UN Sustainable Development Goals (SDGs) (*high confidence*)

- The authors should carefully consider whether they are referring to the Sustainable Development Goals (SDGs), the underlying efforts contained within these goals, or sustainable development generally. Throughout this section, the SDGs seem to be taken as synonymous with sustainable development although they are not the same. One is a set of goals agreed upon by the international community; the other should be largely self-defined by local communities.

D2. Limiting global warming to 1.5°C in the context of sustainable development and poverty

eradication requires a portfolio of mitigation and adaptation actions that work across sectors and scales. These actions would face key barriers and are enabled by change, such as finance, technology and behaviour (*high confidence*).

- This section contains several instances of policy-prescriptive language that does not hew to IPCC principles. The headline reads as an imperative and should be revised to be factual.
- The statement regarding costs in subbullet D2.1 needs to be brought into line with the underlying chapter. The price of emissions discussed in Chapter 2 is the marginal cost of abatement, which is not equivalent to the abatement costs referred to in subbullet D2.1. Furthermore, the SPM does not reflect the main thrust of the point in Chapter 2, namely that all modeled 1.5°C-consistent pathways include policies reflecting a high price on emissions.

D3. Adaptation can reduce vulnerability to global warming of 1.5°C and is mostly beneficial for sustainable development and poverty reduction. There can also be negative consequences (trade-offs) with some of the UN SDGs if actions are not context-specific and managed carefully *(high confidence)*.

- The focus here should be on the sectors not the number of SDGs. The authors should focus on the actions/outcomes that the goals refer to, so revise to say: "...result in tradeoffs to sustainable development, including health..."
- The information should be placed in the broader context of whether adaptation measures are cost-effective or not.

D4. Mitigation consistent with 1.5°C global warming pathways is associated with multiple synergies and trade-offs across a range of UN SDGs, depending on the pace and magnitude of changes and the management of the transition *(high confidence)*.

- The economic risks of the rapid reductions of GHG emissions go beyond impacts on fossil fuel dependent economies. There should be a discussion of the impacts on countries with significant investments in infrastructure (those related to so-called "locked-in" emissions) and how such pathways may inhibit energy access.

D5. Pursuing climate-resilient development pathways can limit warming to 1.5°C while adapting to its consequences and simultaneously achieving sustainable development *(high confidence)*.

- The statement is unqualified, simplistic, and optimistic. The statement implied that to achieve 1.5°C and SDGs, all that is needed is to pursue climate-resilient development pathways. This does not acknowledge the many challenges associated with 1.5°C and the various dimensions of feasibility. A more appropriate top-line statement could be something along the lines of what is found in subbullet D5.1, "Pathways that are consistent with sustainable development are associated with reduced mitigation and adaptation challenges."

D6. Policy implementation to successfully limit warming to 1.5°C and to adapt to global warming of 1.5°C implies international cooperation and strengthening institutional capacity of national and sub-national authorities from civil society, the private sector, cities,

local communities and Indigenous peoples (*high confidence*).

- The statement presents policy-prescriptive commentary that is inappropriate for an IPCC document. The discussion is not specific to 1.5°C of global warming, and any of these findings can and has been found to be true of higher targets as well. A better discussion is needed here on the enabling environments and domestic resources needed to create the incentives for pursuing the rapid transitions implied by limited warming to 1.5°C.

Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/21/2018 2:09:34 AM
To: ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]
CC: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Akhtar, Farhan H [AkhtarFH@state.gov]; sgray@usgs.gov; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]
Subject: Re: reminder: IPCC 48 papers by Wed Sept 19
Attachments: A4 (eh 092018).docx; A5 (eh 092018) - still needs some work.docx; B6 (eh 092018).docx; Fig2 (eh 091418).docx; C2 (eh 091718 second pass) (aaf edits 091818) (2).docx; D4 (eh 092018).docx; D5 (eh 091718).docx; EH General comments on SPM.docx

Hi Alice and all:

Here are a few more sections:

A4, A5, B6, Figure 2, C2, D4, D5. Several of these need further work. I haven't done much with Figure 2 - am hoping Ben can guide us on that.

I've also included some general reflections on the document structure.

I will send an update to B5.5 in the morning. Still working on C3, D2 (unless you have that already?), D3, D6 and will send edited toplines.

best,
Eric

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Senior Advisor
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Bureau for Economic Growth, Education, and Environment
USAID

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On Thu, Sep 20, 2018 at 1:33 PM Alpert, Alice <AlpertA@state.gov> wrote:

> Hello team,
>
> Thank you all very much for the papers you submitted yesterday. We'll sift through these and get back to you with any questions that come up. Please have key edits and questions on your section(s) ready for Trigg on the section by section calls, and please do send the sections below as they are available.
>
> Introduction: Steve
>
> A4: Eric and Farhan
>
> A5: Eric and Farhan with Allen

B6: Eric and Farhan

Figure 2: Ben, Eric, Farhan

C2: Allen and Eric

C3: Allen and Eric

Figure 3: Allen

Figure 4: Farhan

D3: Farhan and Eric

D4: Eric and Allen

D5: Farhan and Eric

D6: Farhan and Eric

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From: Fawcett, Allen <Fawcett.Allen@epa.gov>
Sent: Wednesday, September 19, 2018 5:45 PM
To: Alpert, Alice <AlpertA@state.gov>; Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>
Subject: RE: reminder: IPCC 48 papers by Wed Sept 19

Hey everyone,

Here are my latest write ups for my individual sections. Steve and I iterated on A2, and I've attached our draft here. Eric and I discussed and iterated on A5, C2, and C3, and he has the latest versions of those to send along soon. These could probably all use some more cleaning up, but I didn't want to miss Alice's deadline.

Best,

Allen

Allen A. Fawcett, Ph.D.

Chief, Climate Economics Branch

U.S. Environmental Protection Agency

Office: (202) 343-9436

Cell: (202) 412-5116

From: Alpert, Alice [mailto:AlpertA@state.gov]
Sent: Monday, September 17, 2018 10:44 AM
To: Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; Fawcett, Allen <Fawcett.Allen@epa.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>
Subject: reminder: IPCC 48 papers by Wed Sept 19

Good morning experts,

Please let me know if you will have any trouble submitting strategies on the SPM statements assigned to you by this Wednesday. We are in final preparations for briefing up and are counting on your expert input. Thank you again and let me know if you have any questions.

Alice

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From: Alpert, Alice
Sent: Thursday, September 13, 2018 6:15 PM
To: Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Fawcett, Allen' <Fawcett.Allen@epa.gov>;

'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: 'David Dokken' <ddokken@usgcrp.gov>
Subject: RE: IPCC 48 preparations

Hello team,

This is a reminder to continue preparing for the IPCC meeting in October. Please do not hesitate to reach with any questions you have.

I am attaching the consolidated comments submitted to the IPCC from governments. These will be important to look at carefully because they will be the best way to anticipate the changes to the next iteration of the SPM. Countries that do not see their changes in the next draft may make additions from the floor as well.

I will schedule a call the week of September 24 to make sure we are all prepared for the meeting. (Ben, let's connect next week before you leave)

All the best,

Alice

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From: Alpert, Alice
Sent: Friday, August 31, 2018 4:28 AM
To: Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Fawcett, Allen' <Fawcett.Allen@epa.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>
Subject: IPCC 48 preparations

Hello expert team,

We are starting to prepare our arguments and preferred SPM text for the October meeting. I've outlined a process below for preparing our paper for the meeting, noting that another draft of the SPM will be released immediately ahead of the meeting, or possibly on its first day. Some of our comments on the existing version may be addressed in that draft, and there may also be additions from other countries. So, we will need be prepared to respond in either case.

I have prepared several documents to aid in this preparation:

- a document ("US Toplines") with a topline argument for each SPM heading
- A spreadsheet with the whole SPM comments we submitted that could be useful for arguments on individual SPM statements.
- I have also prepared a word document for each SPM heading, and populated them with the relevant comments we transmitted in July in the heading and its sub-bullets.

Since some of our transmitted comments are mutually inconsistent we will need to develop an official view/objective for each statement and section.

What we are asking you to do is:

- For each SPM heading and sub-heading (e.g., A1 and A1.1, A1.2, and A1.3) relevant to your review, identify if and how you would like the SPM text to be changed. It would be good to also identify one or two acceptable fallback options based on the underlying chapter. Please add the alternate text and references to the underlying chapter, as appropriate, to the specific heading document.
- Edit the comments and topline priority for the statements in the "US Approach" document in track changes, adding talking points to argue for these changes. You may want to remove some comments and focus on a subset that you can further support using the underlying chapter text.

Many of the statements are relevant for more than one reviewer, and I encourage you to coordinate with each other as you prepare. See the list below for suggestions.

We plan to schedule a call to check in and answer questions later this week or next week. Trigg, Farhan, and I will be at a meeting in Bangkok, 11 hours ahead of EDT until September 12th. We'll look to have comments and positions by Sept 19 for final consolidation.

Definitions: all, as relevant

Introduction: Steve

A1: Steve with Ch3

A2: Steve with Allen

A3: Ben with Eric

A4: Eric and Farhan

A5: Eric and Farhan with Allen

Figure 1: Allen and Steve

B1: Ben

B2: Ben

B3: Ben

B4: Ben

B5: Ben, Eric, Farhan

B6: Eric and Farhan

Figure 2: Ben, Eric, Farhan

C1: Allen (with Farhan on C1.2)

C2: Allen and Eric

C3: Allen and Eric

Figure 3: Allen

Figure 4: Farhan

D1: Allen

D2: Farhan and Eric

D3: Farhan and Eric

D4: Eric and Allen

D5: Farhan and Eric

D6: Farhan and Eric

Official

UNCLASSIFIED

Message

From: Alpert, Alice [AlpertA@state.gov]
Sent: 10/9/2018 2:45:45 AM
To: Akhtar, Farhan H [AkhtarFH@state.gov]; Haxthausen, Eric M. (E3/GCC/PEL) [ehaxthausen@usaid.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Stephen Gray [sgray@usgs.gov]
CC: Talley, Trigg [TalleyT@state.gov]; Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]
Subject: SR1.5 draft summary
Attachments: SR1.5_summary_20181009.docx

Thanks a lot for your feedback, Eric. I've revised the attached.

I'm wondering if it would be appropriate to add something along the lines of "In (my) expert opinion, it is virtually certain that warming will not be limited to 1.5C, based on the rate and scale of changes implied."

On Tue, Oct 9, 2018 at 7:49 AM Alpert, Alice <AlpertA@state.gov> wrote:

From: Eric Haxthausen <ehaxthausen@usaid.gov>
Sent: Monday, October 8, 2018 9:51 PM
To: Alpert, Alice
Cc: Akhtar, Farhan H; Fawcett, Allen; Stephen Gray; Talley, Trigg
Subject: SR1.5 draft summary

Hi Alice,
Thanks for this. Some additional points to consider below, space depending. We would be interested in seeing the final memo and annex (redacted if necessary) to share with our leadership.

Best,
Eric

Impacts:

-may be worth mentioning the Arctic sea ice conclusions in b4.1. Also may be worth noting that:

- Arctic ecosystems, dryland regions, small islands, and the least developed countries face the greatest risk of impacts.
- Warming from 1.5 to 2 degrees would mean greater health risks associated with extreme heat and an expanded range of some vector-borne diseases, and greater reductions in yields of many staple crops, particularly at low latitudes.
- Note that the low confidence statement doesn't apply to corals, which is a high confidence finding, or to the points above.

Pathways

- Suggest rephrasing the first point to refer to "estimated emissions associated with NDCs submitted under the Paris Agreement." Arguably the ambition of the PA would be the temperature target(s) themselves.
- Suggest adding a parenthetical "as compared to 2075 for 2degC pathways" following the reference to net-zero by 2050.
- Suggest moving up the penultimate point re "Pathways limiting global warming to 1.5°C would require rapid and far-reaching transitions in energy, land, urban, infrastructure, and industrial systems at unprecedented scale" to the 2nd or 3rd point in this section.
- Re coal - it may be more accurate to say that by 2050, the use of coal would drop by roughly 75% under some pathways and virtually cease under others. Can we elucidate why some pathways allow it and others don't?
- Note that BECCS is Bioenergy *with* ccs
- Also worth noting:
- >>Reducing energy demand (e.g. through improved efficiencies) increases the likelihood and reduces the cost of achieving 1.5 and 2 degree scenarios. Planting forests and bioenergy crops can play a significant role in 1.5 degree pathways, but could necessitate global shifts in land use spanning millions of square miles
- >>The report does not meaningfully assess geoengineering measures focused in changing the absorption of incoming solar radiation.

On Sunday, October 7, 2018, Alpert, Alice <AlpertA@state.gov> wrote:

Hello team,

Please review this draft 1pg summary of SR1.5 findings, with some questions and comments.

This is intended as a factual appendix to a memo describing the meeting and report context.

Alice

--

Eric Haxthausen
Senior Advisor
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USAID

ehaxthausen@usaid.gov
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Message

From: Alpert, Alice [AlpertA@state.gov]
Sent: 10/8/2018 3:42:32 AM
To: Akhtar, Farhan H [AkhtarFH@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Haxthausen, Eric M. (E3/GCC/PEL) [ehaxthausen@usaid.gov]; Stephen Gray [sgray@usgs.gov]
CC: Talley, Trigg [TalleyT@state.gov]
Subject: SR1.5 draft summary
Attachments: SR1.5_summary.docx

Hello team,

Please review this draft 1pg summary of SR1.5 findings, with some questions and comments.

This is intended as a factual appendix to a memo describing the meeting and report context.

Alice

Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 10/6/2018 4:20:18 AM
To: Talley, Trigg [talleyt@state.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]; ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Gray, Stephen [sgray@usgs.gov]
Subject: Vox on report

This is a pretty balanced report.

https://www.vox.com/platform/amp/2018/10/5/17934174/climate-change-global-warming-un-ipcc-report-1-5-degrees

--

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Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 10/5/2018 3:43:01 PM
To: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: Fwd: IPCC Statement

---------- Forwarded message ----------
From: **trigg talley** <triggtalley@yahoo.com>
Date: Saturday, October 6, 2018
Subject: IPCC Statement
To: "Talley, Trigg" <TalleyT@state.gov>, "Andrew C. Neustaetter" <neustaetterac@state.gov>, Holly Kirking Loomis <kirkingha@state.gov>, "Farhan H. Akhtar" <akhtarfh@state.gov>, Alice Alpert <alperta@state.gov>, "faucett.allen@epa.gov" <faucett.allen@epa.gov>, Eric Haxthausen <ehaxthausen@usaid.gov>, Kim Carnahan <kimcarnahan@gmail.com>, "Hannah J. Lyons" <lyonshj2@state.gov>, trigg t <talleyt@state.gov>, "John E. EOP/NSC Thompson" <john.e.thompson@nsc.eop.gov>

Hi all - We are slogging through the last 20% of the material or so. I anticipate that we will work all night and finalize the special report sometime around mid-day Saturday Korea time. Our delegation has done very well here, and we've had good success in achieving more rigor in the report.

I have tightened up the statement a bit. No appreciable difference in substance, so dont think it needs to be re-cleared, but Andy (and anyone else) let me know if you have comments. I'd like to get something back before your COB if you have comments. We'll read it in the final plenary, sometime late your Friday.

Statement of the United States of America on the IPCC Special Report on Global Warming of 1.5C at the Forty Eighth Session of the Intergovernmental Panel on Climate Change

October 6, 2018

The United States appreciates the hard work of the scientists and experts who authored this report under considerable time pressure, and we have appreciated our engagement with other members of the Panel to finalize this Special Report by accepting the report from its authors and approving its Summary for Policy Makers.

With respect to acceptance of the Special Report, as provided in the IPCC's procedures, the contents of the authored chapters have not been subject to line-by-line discussion and agreement, and remain the responsibility of the authors. In this context, the United States notes that acceptance of this report by the Panel does not imply endorsement by the United States of the specific findings or underlying contents of the report.

With respect to approval of the Summary for Policy Makers (SPM), we underscore that, as provided in IPCC procedures, approval signifies that the SPM is consistent with the factual material contained in the full report.

Given that the underlying contents of the report are not subject to agreement by members of the panel, approval of the SPM similarly should not be understood as U.S. endorsement of all of the findings and key messages included in the SPM.

With respect to the report as a whole, several sections of the report acknowledge that literature that relates specifically to impacts at 1.5C is more limited than many other aspects of the climate issue, and that much of the literature assessed is quite recent.

We observe that there are a number of inherent limitations in the confidence of modeled results of impacts, costs, and related issues at specific future temperature levels, and more so at the particular levels addressed by this report.

Finally, we note that parts of the underlying report were substantially revised following the second order draft, including in a number of cases with new literature made available only after the circulation of that draft, and that these revisions were not subject to full government and expert review.

--

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Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 10/5/2018 4:44:28 AM
To: Talley, Trigg [talleyt@state.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]; ALPERT Alice (AlpertA@state.gov) [AlpertA@state.gov]; Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]; Gray, Stephen [sgray@usgs.gov]
Subject: SciDevNet article on US engagement at IPCC

- Home
- Climate change
- News

https://www.scidev.net/global/climate-change/news/us-prising-climate-development-apart-in-ipcc-talks.html

04/10/18

US prising climate, development apart in IPCC talks

Greenpeace hot air balloon outside Oslo Town Hall that reads Stop Global Warming. / Copyright: Panos

Speed read

- US plans to withdraw from Paris deal
- US questions negative impact of climate change
- Discussions part of IPCC talks on 1.5 degrees report

By: Lou Del Bello

[NEW DELHI] US negotiators at key global climate talks are working to prise climate and development apart, documents seen by SciDev.Net show, in a challenge to the orthodoxy that has inextricably linked the two since the establishment of the Sustainable Development Goals in 2015.

Countries around the world are gathered in Incheon, South Korea, this week to thrash out a landmark UN report on whether the world can keep global warming to within 1.5 degrees Celsius above pre-industrial levels – the most optimistic objective set by governments in the 2015 Paris Agreement.

The meeting, convened under the UN's Intergovernmental Panel on Climate Change (IPCC), is to agree the wording of the Summary for Policymakers, a politically charged part of the wider report which sets out the key messages and findings.

> *"Anybody who's trying to prevent action is challenging [well established] science, and that's what the United States is doing,"*
>
> ***Saleemul Huq***

In a series of detailed comments to the draft seen by SciDev.Net, the US delegation notes that the report focuses too much on sustainable development and should focus on the "assessment of climate change science" only.

"The IPCC … should not take it upon itself to plot a vision for global attainment of sustainable development goals via climate policy," the delegation writes.

The Paris Agreement was hailed as a major step forward in combatting man-made climate change. However, US President Donal Trump announced last year that US would withdraw from the agreement.

From the idea that humanity will be worse off living on a warming planet, to the belief that climate change and development are two sides of the same challenge, the comments mean the US is questioning some of the most fundamental principles underpinning the Paris Agreement.

"Anybody who's trying to prevent action is challenging [well established] science, and that's what the United States is doing," says IPCC author Saleemul Huq, who heads the International Centre for Climate Change and Development in Bangladesh.

Serious consequences

However, others fear that decoupling climate action and the Sustainable Development Goals could be an effective strategy with serious consequences.

"The developed world already has a disproportionate lobbying power within the UN climate framework," says Vijeta Rattani, climate change programme manager with the Centre for Science and Environment in New Delhi, India.

If the voice of developing nations was not listened to, she says, "they would be forced to revise their [climate pledges under the Paris Agreement] substantially and drastically in the next cycle [of negotiations]".

In the comments, the US questions the core premise of the upcoming report, that the world would be worse off as the world warms.

Humanity, it says quoting a number of published studies, "has never been more prosperous, less poverty-stricken, less hungry, longer-lived and healthier than today". It cites the example of India and China as two nations that are still relying heavily on fossil fuels but are also thriving economically.

The arguments tabled by the US, says Teresa Anderson, Policy officer on Climate Change with Action Aid, "are part of the same effort to remove the recognition of the impacts of climate change and undercut the purpose of this report".

You might also like

- Study counts lives saved with push for 1.5°C climate target
- Climate goal in peril as science points to 3 degree warming
- IPCC to assess impact of 1.5 degree warming
- Joint action on climate change
- Water security & climate change
- Climate change after Gleneagles

When the IPCC was given a mandate to assess climate science underpinning the 1.5°C target, she says, the study of impacts was clearly mentioned, and the SDGs are the best tool available to assess them against measurable goals.

"These two frameworks (IPCC and SDGs) are completely interlinked, they are a cobweb of institutions and you can't really achieve one without the other," she says.

For coastal communities in Bangladesh losing the land to rising sea levels or experiencing cyclones every year, she says, or for African farmers going hungry because of crop failure, "[to hear] that climate change is making you wealthier is kind of insulting and cruel".

In an emailed statement, the US delegation said: "The United States is leading the world in providing affordable, abundant, and secure energy to our citizens, while protecting the environment and reducing emissions through job-creating innovation rather than job-killing regulation."

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Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/14/2018 11:18:30 PM
To: Benjamin DeAngelo - NOAA Federal [ben.deangelo@noaa.gov]; Akhtar, Farhan H [AkhtarFH@state.gov]
CC: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: Fwd: IPCC 48 preparations - B5 and Figure SPM2
Attachments: B5 (eh 091418).docx

Deliberative Process / Ex. 5

best,
Eric

Eric Haxthausen
Senior Advisor
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+1 (202) 550-3343 (mobile)

---------- Forwarded message ---------
From: **Alpert, Alice** <AlpertA@state.gov>
Date: Fri, Aug 31, 2018 at 4:31 AM
Subject: IPCC 48 preparations
To: Akhtar, Farhan H <AkhtarFH@state.gov>, Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>, Gray, Stephen <sgray@usgs.gov>, Fawcett, Allen <Fawcett.Allen@epa.gov>, Benjamin DeAngelo - NOAA Federal <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>

Hello expert team,

Deliberative Process / Ex. 5

Deliberative Process / Ex. 5

Official

UNCLASSIFIED

Message

From: Eric Haxthausen [ehaxthausen@usaid.gov]
Sent: 9/13/2018 11:20:38 PM
To: Fawcett, Allen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c42c443c02834519bd99d9826afccf54-AFAWCETT]
Subject: Fwd: IPCC 48 preparations
Attachments: WG-I WG-II amp; WG-III_ 1st_INF.1 Collated comments from Governments on the Final Draft Summary for Policymakers_.pdf

Allen, note comment 3240 from Germany, related to our conversation earlier today. Best, Eric

Eric Haxthausen
Senior Advisor
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+1 (202) 550-3343 (mobile)

---------- Forwarded message ---------
From: **Alpert, Alice** <AlpertA@state.gov>
Date: Thu, Sep 13, 2018 at 6:26 PM
Subject: RE: IPCC 48 preparations
To: Akhtar, Farhan H <AkhtarFH@state.gov>, Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>, Gray, Stephen <sgray@usgs.gov>, Fawcett, Allen <Fawcett.Allen@epa.gov>, Benjamin DeAngelo - NOAA Federal <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>

Hello team,

This is a reminder to continue preparing for the IPCC meeting in October. Please do not hesitate to reach with any questions you have.

I am attaching the consolidated comments submitted to the IPCC from governments. These will be important to look at carefully because they will be the best way to anticipate the changes to the next iteration of the SPM. Countries that do not see their changes in the next draft may make additions from the floor as well.

I will schedule a call the week of September 24 to make sure we are all prepared for the meeting. (Ben, let's connect next week before you leave)

All the best,

Alice

Official

UNCLASSIFIED

From: Alpert, Alice
Sent: Friday, August 31, 2018 4:28 AM
To: Akhtar, Farhan H <AkhtarFH@state.gov>; Haxthausen, Eric M. (E3/GCC/PEL) <ehaxthausen@usaid.gov>; 'Gray, Stephen' <sgray@usgs.gov>; 'Fawcett, Allen' <Fawcett.Allen@epa.gov>; 'Benjamin DeAngelo - NOAA Federal' <ben.deangelo@noaa.gov>
Cc: David Dokken <ddokken@usgcrp.gov>
Subject: IPCC 48 preparations

Hello expert team,

We are starting to prepare our arguments and preferred SPM text for the October meeting. I've outlined a process below for preparing our paper for the meeting, noting that another draft of the SPM will be released immediately ahead of the meeting, or possibly on its first day. Some of our comments on the existing version may be addressed in that draft, and there may also be additions from other countries. So, we will need be prepared to respond in either case.

I have prepared several documents to aid in this preparation:

- a document ("US Toplines") with a topline argument for each SPM heading
- A spreadsheet with the whole SPM comments we submitted that could be useful for arguments on individual SPM statements.
- I have also prepared a word document for each SPM heading, and populated them with the relevant comments we transmitted in July in the heading and its sub-bullets.

Since some of our transmitted comments are mutually inconsistent we will need to develop an official view/objective for each statement and section.

What we are asking you to do is:

- For each SPM heading and sub-heading (e.g., A1 and A1.1, A1.2, and A1.3) relevant to your review, identify if and how you would like the SPM text to be changed. It would be good to also identify one or two acceptable fallback options based on the underlying chapter. Please add the alternate text and references to the underlying chapter, as appropriate, to the specific heading document.

- Edit the comments and topline priority for the statements in the "US Approach" document in track changes, adding talking points to argue for these changes. You may want to remove some comments and focus on a subset that you can further support using the underlying chapter text.

Many of the statements are relevant for more than one reviewer, and I encourage you to coordinate with each other as you prepare. See the list below for suggestions.

We plan to schedule a call to check in and answer questions later this week or next week. Trigg, Farhan, and I will be at a meeting in Bangkok, 11 hours ahead of EDT until September 12th. We'll look to have comments and positions by Sept 19 for final consolidation.

Definitions: all, as relevant

Introduction: Steve

A1: Steve with Ch3

A2: Steve with Allen

A3: Ben with Eric

A4: Eric and Farhan

A5: Eric and Farhan with Allen

Figure 1: Allen and Steve

B1: Ben

B2: Ben

B3: Ben

B4: Ben

B5: Ben, Eric, Farhan

B6: Eric and Farhan

Figure 2: Ben, Eric, Farhan

C1: Allen (with Farhan on C1.2)

C2: Allen and Eric

C3: Allen and Eric

Figure 3: Allen

Figure 4: Farhan

D1: Allen

D2: Farhan and Eric

D3: Farhan and Eric

D4: Eric and Allen

D5: Farhan and Eric

D6: Farhan and Eric

Message

From: Schneider, Daniel J. EOP/CEQ EOP / Ex. 6
Sent: 10/8/2018 3:51:36 PM
To: Konkus, John [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=555471b2baa6419e8e141696f4577062-Konkus, Joh]
CC: Parkinson, Zach Z. EOP/WHO EOP / Ex. 6
Subject: Re: IPCC report on global warming

Thanks for flagging, John.

Sent from my iPhone

> On Oct 8, 2018, at 10:38 AM, Konkus, John <konkus.john@epa.gov> wrote:
>
> Dan: Please see below. The statement is directly from CEQ's talking points.
>>
>> IPCC Inquiries thru 10:30am today:
>>>
>>> The Guardian
>>> S&P Global
>>> BBC
>>> ABC
>>> The Hill
>>
>> Statement we're using:
>>
>> "We appreciate the hard work of the scientists and experts, many from the United States, who developed this report under considerable time pressure. In accordance with IPCC procedures, the report and its contents remain the responsibility of its authors. Governments do not formally endorse specific findings presented by the authors." — EPA Spokesman
>
> John Konkus
> Environmental Protection Agency
> Deputy Associate Administrator
> Office of Public Affairs

Message

From: Konkus, John [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=555471B2BAA6419E8E141696F4577062-KONKUS, JOH]
Sent: 10/8/2018 2:34:28 PM
To: Andrew.Z.Parkinson@who EOP / Ex. 6
Subject: IPCC report on global warming

Zach: Can you please maker sure Dan at CEQ has this? I don't have his email address. The statement is directly from CEQ's talking points. Thank you!

IPCC Inquiries thru 10:30am today:
>
> The Guardian
> S&P Global
> BBC
> ABC
> The Hill

Statement we're using:

"We appreciate the hard work of the scientists and experts, many from the United States, who developed this report under considerable time pressure. In accordance with IPCC procedures, the report and its contents remain the responsibility of its authors. Governments do not formally endorse specific findings presented by the authors." – EPA Spokesman